Market efficiency and performance dynamics of International Exchange-Traded Funds

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Stephen Bahadar

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"I dedicate this effort to my parents for their

countless sacrifices, unfailing kindness, unconditional love …"

Abstract of a thesis submitted in partial fulfilment of the requirements for the Degree of Doctor of Philosophy in Finance.

Abstract

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by

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Despite persistent economic and political volatility in the world, the Exchange-Traded Fund (ETF) industry continues to experience popularity and growth since the invention of the first ETF. This growth of the ETF industry is not just in scale but in sophistication as well. A variety of ETFs now cater for different investment needs of the global investors and International ETF is one of the sophisticated types of ETF which is designed to mirror the performance of its foreign benchmark index. International ETFs promise some very distinguishing features to investors such as continuous trading, higher international diversification, lower management fee and higher tax efficiency. Majority of the International ETFs are listed in the US and tracks the indices of foreign markets which has non-synchronous trading hours with the US market. The asynchronous trading hours between the markets of Exchange-Traded Funds (ETFs) and their benchmarks not only make it difficult to apply *full replication strategy* but also make the *creation/redemption process (the arbitrage mechanism)* ineffective and consequently effects the market efficiency and distress the performance of international ETFs. Despite the exponential growth of ETF industry in general and international ETFs in particular, the market efficiency and performance dynamics of international ETFs are still under-researched.

This study evaluates (1) the market efficiency by analysing the *random behaviour and calendar anomalies* in the International ETFs; and (2) the performance dynamics of International ETFs by analysing their *returns and return volatilities, tracking abilities and pricing efficiencies*. The study includes a sample of 56 US-listed International ETFs offering the exposure of Asia-Pacific and European markets. Next, the study employs Lo and MacKinlay (1988) individual variance ratio and Chow and Denning (1993) multiple variance ratio to examine whether International ETFs follow a random walk. ARMA-GARCH model is used to investigate the presence and persistence of calendar anomalies in the international ETF returns over time. We estimate the return and volatility in trading price and NAV to

distinguish their behaviour; and to compare the return volatility during the trading hours (intraday) and non-trading hours (i.e. overnight), we also calculate and compare return and volatility during intraday and overnight periods. Moreover, to evaluate the risk-adjusted performance, we employ capital asset pricing model (CAPM) model by regressing trading price returns and NAV returns of International ETFs on their corresponding benchmark returns after adjusting both with a risk-free return. Tracking errors in trading price returns and NAV returns are estimated using the two methods (1) the absolute difference in ETF and its benchmark returns and (2) the standard deviation of the difference in ETF and its benchmark returns; and second-order autoregressive model by regressing the tracking errors on the values of their two lagged days. To measure the pricing inefficiency of International ETFs, we use two methods (1) percentage change in closing price of ETFs and NAV and (2) OLS by regressing trading price of ETFs on its NAV; and to examine the persistence of pricing inefficiency in International ETFs, we regress the estimated price deviation on its two day lagged values using the second-order autoregressive model.

The findings of this study are equally useful for investors and practitioners interested to understand the market efficiency and performance dynamics of International ETFs. As a pioneer study, it not only fills the research gap in the literature of international ETFs but it also contributes to the existing literature on random walk hypothesis, calendar anomalies, efficient market hypothesis and adaptive market hypothesis by investigating these phenomenon using a relatively new asset class. The conception of random walk and calendar anomalies enable investors and practitioners to make the most of any informational inefficiency in the returns of international ETFs by applying various optimal investment strategies. The comprehensive findings on the behaviour of risk and return, tracking error and pricing inefficiency help investors and practitioners to better understand the trading mechanism and be adaptive in response to the performance metrics explored in this study.

Keywords: Exchange-Traded Funds, Tracking Performance, Pricing Inefficiency, Calendar Anomalies, Random Walk Hypothesis

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Chapter 1

Overview of the study

1.1 Introduction

Chapter 1 is about the overview of the study. Section 1.2 presents the rational of the study, a brief discussion on the evolution and growth of ETF; then explains the scarcity of literature on international ETF by summarizing the existing ETF literature and highlights the important concerns of the investors seeking exposure of foreign indices by investing in international ETFs. Subsequently, section 1.2 provides the research problem statement based on the major concerns of the investors. Section 1.3 discusses the main research objectives based on the problem statement. Section 1.4 describes the significance of the study. The final section of this chapter concludes by describing the structure and organization of the study.

1.2 Rationale of the study

An Exchange Traded Fund (hereafter ETF) is a pooled investment vehicle that tracks a particular index, as index fund as well as publically traded on stock exchanges, as a common stock. At their core, ETFs are hybrid investment products, with many of the characteristics of mutual funds with a feature of tradability like any common stocks (Groves, 2011). Like a mutual fund, an investor buys shares in an ETF to own a proportional interest in the pooled assets. Like mutual funds, ETFs are generally managed by an investment advisor for a fee. But unlike mutual funds, ETF shares are traded in continuous markets on global stock exchanges, can be bought and sold through brokerage accounts, and have continuous pricing and liquidity throughout the trading day. Thus, they can be margined, lent short or subject to any other strategy used by sophisticated equity investors (Hill, Nadig, Hougan, & Fuhr, 2015).

However, Exchange Traded Products (hereafter ETPs) have experienced a surge in popularity and become a disruptive innovation since the invention of the first ETF; whereas the possibilities of their application has increased. At the end of 1993, there was only one ETF on the market, with assets of $464 million. By the end of 1997, there were only two ETFs trading on U.S. exchanges, with assets value totaling $6.2 billion. Following this, the idea started to catch on. ETF issuance began to accelerate as more investment companies entered the marketplace (Ferri, 2011).

Mercado, Lan, and Rejendra (2017) report that Global ETP assets reached a new milestone in 2016 with a $3.5 trillion mark, representing a year over year (YoY) growth of 18%. The growth was mostly organic[1] with flows and asset prices increase to 13%, and 5%, respectively. The authors further describe that during 2016, total inflows of $381bn were led by equities bringing in $249bn, followed by fixed income with $106bn, and commodity ETPs which also saw positive, albeit smaller, flows of $23bn. In 2016, the US ETP market led the inflow tally with an all-time high of $284bn, followed in the distance by the European and Asia-Pacific ETP markets with inflows of $55bn and 31bn, respectively. Meanwhile, the other markets (Rest of the World) attracted $12bn in net new assets.

BlackRock a multinational company based in the US, with its renowned brand iShares, is the largest ETP provider in the world with more than 763 funds and over USD 1,059 billion of Assets under Management (hereafter AuM), estimates that the ETP industry grew from worldwide 106 products with USD 79,4 billion AuM in 2002 to 5,867 ETPs with USD 2,834.5 billion AuM in February 2016 (BlackRock Inc., 2016). This trend seems to continue as the industry grows across all markets and segments. Lower cost structure and the inability of almost all active funds to outperform indexes are the causes of the growth in ETFs industry (Pisani, 2015).

This success of ETFs has attracted the attention of academic researchers which has started the development of literature on ETFs. The existing literature on ETFs can be grouped into four strands, each of which addresses four different aspects of the trading characteristics of ETFs. The first strand of previous studies (Ackert & Tian, 2000; Bas & Sarioglu, 2015; Charupat & Miu, 2013b; Dorfleitner, Gerl, & Gerer, 2017; Elton, Gruber, Comer, & Li, 2002; Engle & Sarkar, 2006; Jiang, Guo, & Lan, 2010; Kayali, 2007; Lin, Chan, & Hsu, 2006; Prusevic, 2012; Purohit & Malhotra, 2015; Swathy, 2015; Tripathi & Garg, 2016) focus on ETFs' pricing efficiency, i.e. does market price of ETF closely replicate the net asset values (NAVs) of it underlying index? If there exist a pricing error how quickly does it disappear? These studies attempt to investigate the effectiveness of the creation/redemption process in arbitraging away the differences between the market prices of ETF and NAV of its benchmark index.

The second strand of literature (Bas & Sarioglu, 2015; Chu, 2011, 2013; Dingelstad, 2015; Elia, 2012; Frino & Gallagher, 2001; Johnson, 2009; Pope & Yadav, 1994; Rompotis, 2010b; Shin & Soydemir, 2010) examine the performance of ETFs, i.e. how successful they are in tracking the performance of

[1] Organic growth is a term defined as the growth rate of an entity due to the increased output and enhanced sales.

their benchmark indices. This is normally done by measuring ETFs' tracking errors. Previous studies use (Chu, 2011; Frino & Gallagher, 2002; Frino, Gallagher, & Oetomo, 2005; Rompotis, 2005; Wong & Shum, 2010) five different variants of computing ETFs' tracking error.

The third group of studies (Blume & Edelen, 2004; De Winnea, Gresseb, & Plattena, 2008; Hamm, 2010; Ivanov, 2016; Rompotis, 2010a; Sultan) look at the effects of ETF trading on related assets such as constituent equities of the benchmark indices and financial derivatives on those benchmark indices. These studies investigate whether there is a change in their trading characteristics (e.g. bid-ask spreads, trading volume, etc.) of the constituent equities of the benchmark indices after the introduction of the ETFs. This change in trading characteristics of underlying stocks indicate a migration of investors. Further such studies also examine if the introduction of ETFs assists arbitrage activities (i.e. ETFs help arbitrageurs to short the underlying indices, even on a downtick) which will cause the derivative pricing more efficient.

The debate on the comparison of ETFs and index funds has attracted extensive interest in the literature because these two investment products are regarded as competitors. The fourth set of studies (Agapova, 2011; Antonov & Schirra, 2013; Blitz, Huij, & Swinkels, 2012; Garg & Singh, 2013; Rompotis, 2005, 2008, 2013b; Sharifzadeh & Hojat, 2012) compares these products on the bases of their cost, performance and tracking ability.

As discussed above, previous literature is more concentrated on determining the (1) pricing efficiency (2) tracking ability (3) effect of ETFs' introduction on other financial assets and (4) the significant difference between ETFs and index funds. A majority of the literature focused on the traditional domestic ETFs which seeks the performance of domestic benchmarks while the literature on international ETFs is still in its infancy.

International ETFs erase the global boundaries for investors worldwide and enable them to get the exposure to foreign securities from their home exchanges. The cross border investment of global investors through international ETFs has significantly been increased over the recent years; and in parallel the questions relating to the market efficiency and performance dynamics of international ETFs have become the matter of concerns for the investors. This study aims to address these concerns of the investors of international ETFs by providing them reliable empirical answers for their key questions.

1.3 Problem statement

The globalization and advancement of technology is unceasingly contributing in the integration of global capital markets. According to Cerny (1994) financial globalization increasingly constrains policymakers and confines the policy capacity. However, from the investors' perspective, financial globalization enables them to obtain international diversification benefit through investing in potential global markets.

International ETFs were first introduced in 1996 by Black Rock Inc., the world's largest ETF provider (Wagner, 2011). The objective of international ETFs is to facilitate every investor, such as institutional and retail, to directly invest and obtain the exposure of promising global capital market indices from their home country stock exchanges (Levy & Lieberman, 2013). Previously it was difficult for investors to directly invest in certain foreign markets due to a number of restrictions on international capital flow such as capital market, exchange rules and regulations, extreme transaction and higher cost of information (Chang, Eun, and Kolodny (1995). For example, international investors need QFII (qualified foreign institutional investor) license to trade in the Chinese "A-share" market which comprises of the 75% of the total market capitalization of over 2000 Chinese firms (Mistry, 2013). These barriers have stimulated the innovation of many investment products to facilitate international investment. These products include International Mutual Funds, American Depository Receipts (ADRs), Closed-End Country Funds (CECFs) and International ETFs which are the most popular of all. It is because of their unique hybrid structure which simultaneously possesses the characteristics of stocks and mutual funds.

The motivation of this study is threefold. First, the return generation process in the informationally efficient market are random and driven by unforeseen events and cannot be predicted based on the historical returns (Samuelson, 1965). Therefore, any information asymmetry in the market significantly affects the performance of the financial asset. In case of International ETFs, majority of these ETFs are listed in the US market and has asynchronous trading hours with the markets of their tracking indices. And asynchronous trading hours between ETFs' and Indices' markets not only make it difficult to apply *full replication strategy* but also make the *creation/redemption process (the arbitrage mechanism)* ineffective and consequently effects the informational efficiency, pricing efficiency and tracking ability of the International ETFs.

Second, the type of 'replication strategies' used by international ETFs to mirror the performance of their underlying indices. Generally, passively-managed ETFs use physical (either full or optimized) strategies and actively-managed ETFs employ synthetic replication strategies to mirror the performance of their benchmarks. The physical replication strategies are relatively expensive in terms of transaction costs[2], especially for broad indices that are composed of hundreds of securities or indices which consist of volatile and illiquid securities (Maurer & Williams, 2015). According to Dickson, Mance, and Rowley Jr. (2013), the ETFs (whether domestic or international), following any physical replication strategy, are less likely to consistently track their benchmark indices and expose investors to the risk of tracking error. Svetina (2010) compares the tracking performance of domestic ETFs to the international ETFs and confirms that the tracking error of international ETFs is more than the double of domestic ETFs.

Third, the unique *Creation/Redemption process* of ETFs, which takes place in the primary market between the authorized market makers and the ETF issuer. Thus the Creation/Redemption of ETF shares immediately arbitrage away the price discrepancies of ETFs in the secondary market (i.e. stock exchange). Ma (2015) argues that the Creation/Redemption process is effective only if the ETF shares and underlying securities are traded synchronically, as in the case of domestic ETFs; however, for International ETFs where there are asynchronous trading hours between the markets of international ETFs and benchmark indices. For instance, Asian-pacific markets have completely asynchronous trading hours with the US market while the European markets only have partial synchronous trading hours with the US market (Levy & Lieberman, 2013). In such cases, the arbitrage mechanism becomes ineffective (Campbell, Lo, & MacKinlay, 1997a). Consequently, the trading prices of international ETFs fluctuate during the US trading day while their NAVs remain stale and thus make international ETFs to trade at large premiums or discounts compared to their underlying foreign stale NAVs (Shum, 2010).

Therefore, despite the fact that international ETFs offer some very distinguishing features such as continuous trading, higher international diversification, lower management fee and higher tax efficiency (Rompotis, 2015), these ETFs may suffer from issues such as informational inefficiency, tracking error and pricing deviation and are main concerns for the investors and practitioners.

1.4 Purpose of the study

In this respect, this study endeavours to empirically observe the returns of the US-listed international ETFs whether they are informationally efficient and serve the purpose they are designed for. The

[2] Transaction cost refers to the buying and selling of underlying securities. It is not included in the expense ratio (or management fee) charged by the ETF issuers.

purpose of this study is twofold, First is to examine the market (or informational) efficiency by analysing the randomness and calendar effect in the returns of international ETFs and second is to evaluate the performance dynamics of international ETFs by empirically investigating the returns and volatilities behaviour, tracking ability and pricing inefficiency of International ETFs.

1.5 Research objectives of the study

There are seven research objectives in this study. The first two objectives are related to the market efficiency while rest of the five objectives are about the performance dynamics of International ETFs:

1.1.1. To examine the random walk of the international ETF returns.
1.1.2. To determine the presence of calendar effects in the international ETF returns.
1.1.3. To distinguish the behaviour of international ETF returns and volatilities estimated in trading prices and NAV and determine which of the two, (1) trading price return (volatility) and (2) NAV return (volatility) is a better replicator of benchmark.
1.1.4. To analyse the intraday and overnight behaviour of return volatilities of international ETFs.
1.1.5. To evaluate the risk-adjusted performance of international ETFs compare to their benchmark indices.
1.1.6. To investigate how well international ETFs tracks the performance of their benchmark indices and determine the persistence of tracking error (if any) over time.
1.1.7. To examine how closely international ETFs trade to their NAV and also test if the pricing inefficiency (if any) persists over time.

1.6 Significance of the study

Given, the increased interest of investors to invest in the foreign stock markets over the recent years, this study is an endeavour to provide reliable empirical answers to the main questions on market efficiency and performance dynamics of international ETFs. Overall, the findings of this study are significant for investors interested in international diversification benefits by investing in international ETFs.

Considerable empirical literature tested Random Walk Hypothesis (RWH) for the return series of different financial assets such as stocks and indices (Abraham, Seyyed, & Alsakran, 2002; Dockery & Vergari, 1997), corporate bonds (Martinez, Guercio, Bariviera, & Terceño, 2018), commodities (Ntim, English, Nwachukwu, & Wang, 2015; Smith, 2002), foreign exchange rate (Choi, 1999; Liu & He, 1991; Smoluk, Vasconcellos, & Kramer, 1998), financial derivatives e.g. futures (Pan, Chan, & Fok, 1997) and options (Jiang & Tian, 2012). However, previous studies are mainly concentrated on testing the random walk characteristics of stocks and indices. Only a few studies attempted to investigate the randomness of relatively new financial instruments such as ETFs. One such study is Rompotis (2011b) who investigated the daily return series of a range (i.e. Broad, International, Sector) of 66 US-listed ETFs for the period 2001-2010 and found that Efficient Market Hypothesis (EMH) holds in the ETF market. The author's finding might hold true for regular ETFs but not for the exclusive case of international ETFs because most of the US-listed international ETFs track the performance of foreign markets having non-synchronous trading hours with US. Therefore, this study aims to analyse the random walk to answer the question on predictability of international ETFs return on the basis of historical prices.

A number of calendar anomalies found to have significant predictive ability in a large body of literature (Brusa, Liu, & Schulman, 2005; Lakonishok & Maberly, 1990; Marquering, Nisser, & Valla, 2006), which is inconsistent with the EMH. Calendar anomalies were first reported by Wachtel (1942), refer to the systematically different behaviour of stock markets on different day-of-the-week, turn-of-the-month, or month-of-the-year etc. These calendar anomalies in the market can be exploited by employing '*implied trading strategies*' to generate abnormal profits (Caporale & Zakirova, 2017). From a theoretical viewpoint, EMH assume the perfect efficiency i.e. all-or-nothing condition for market efficiency and therefore it contradicts with calendar anomalies. However, the idea of relative efficiency tossed by Campbell, Lo, and MacKinlay (1997b) led to a shift from testing market efficiency as an all-or-nothing condition to measuring the market efficiency over time. Lo (2004) proposes a new theory that enables the market efficiency to vary over time and for the EMH and market inefficiencies to co-exist in an intellectually consistent manner. This new theory is called the Adaptive Market Hypothesis (AMH) under which the EMH and calendar anomalies can co-exist. This study is therefore important, as it not only investigate the presence of calendar anomalies such as 'Monday effect' and 'January effect' in the international ETF returns but it also examines the changing behaviour of these calendar anomalies over time to determine whether the AMH is appropriate to explain the behaviour of calendar anomalies.

Since the introduction of the first international ETF in 1996, several studies endeavour to analyse the performance of international ETFs considering their daily, intraday and overnight returns and volatilities (Rompotis, 2015; Tse & Martinez, 2007), risk-adjusted performance (Rompotis, 2015; Tsai

& Swanson, 2009), tracking ability (Purohit, Choudhary, & Tyagi, 2014; Ramos, 2015) and pricing inefficiency (Delcoure & Zhong, 2007; Engle & Sarkar, 2006) of international ETFs; but no study has exclusively and comprehensively evaluate the performance dynamics of international ETFs, as this study is intended to. The findings of this study on the performance of international ETFs in particular will help investors to distinguish between the return and volatility estimated in trading price and NAV, to understand the intraday and overnight return volatility behaviour, tracking ability[3] and tracking error[4], pricing efficiency[5] and persistence in premiums (or discounts)[6] of the international ETFs. These findings provide investors with significant information they need so as to make more informed investment decisions.

1.7 Structure of the study

The rest of the thesis is structured as follows. Chapter two describes the background and evolution of ETFs. Chapter three reviews the important literature related to the current study. Chapter four describes sample selection and research methods use to examine each research objective. Chapter five reports and discusses the results of the study. Finally, chapter six concludes the study with key findings, contributions and limitations of this study; it also outlines the directions and recommendations for future research.

[3] Tracking ability means how efficient ETF is in mirroring the returns of its benchmarks?
[4] Tracking error is the deviation of ETF return from the return of its benchmark.
[5] Pricing efficiency means how well the price of ETF replicates the NAV of the underlying portfolio?
[6] Persistence of premium (or discount) means how long ETF trades on premium (or discount)?

Chapter 2

Exchange-Traded Funds: The story of most successful financial innovation

2.1 Introduction

Chapter 2 constitutes an introduction to the ETFs, which are one of the most successful financial innovations of the last two decades. Section 2.2 provides a brief historical background of the evolution in ETF market. Section 2.3 describes the unique characteristics and benefits, which made ETFs proliferate among investors worldwide. A discussion on the legal structure based on which the ETFs are developed is presented in Section 2.4. Section 2.5, 2.6 and 2.7 discuss the working mechanism, replication strategies and various type of ETFs, respectively. Section 2.8 summarizes the Chapter.

2.2 Historical background

An investment portfolio is a collection of income-producing assets that have been bought to meet financial goals. Fifty years ago no one would have the slightest clue about portfolio investment. It is amazing that something as fundamental as an investment portfolio did not exist until the late 1960s. The idea of investment portfolios has become so entrenched that we cannot imagine a world without them, but it wasn't always that way (Beattie, 2016).

In the 1970s, modern portfolio theory (first introduced by Harry Markowitz in the 1950s and enriched by William Sharpe and others in the 1960s) began to be incorporated into institutional investment products. Together with these innovations came the concept that investors might be better off "buying the market" than picking individual stocks. This idea was popularized by Burton Malkiel in his seminal 1973 book *A Random Walk Down Wall Street* (Hill et al., 2015). As a result, the first index fund was a strategy structured by Wells Fargo Investment Advisors for the Samsonite Corporation pension fund in 1971 and in 1975, the first index mutual fund launched by John Bogle of Vanguard Group. Since that time, the US equity index funds as a percentage of the US mutual fund assets have grown tremendously (Baird, 2009).

From developments in portfolio trading that originally served only large investors, there arose interest in readily tradable portfolio or basket products for individual investors. Explaining the history of ETF

Gastineau (2010) wrote in his book "The Exchange-Traded Funds Manual" that the first real attempt at something like an ETF was the launch of Index Participation Shares for the S&P 500 in 1989. Unfortunately, a federal court in Chicago ruled that the fund worked like futures contracts, even though they were marginalized and collateralized like a stock; consequently, if they were to be traded they had to be traded on a futures exchange, and the advent of ETFs trading had to be delayed. Gastineau further explained that the next attempt at the creation of the modern ETF was launched by the Toronto Stock Exchange in 1990 and called Toronto 35 Index Participation Units (TIPs 35). These were a warehouse, receipt-based instrument that tracked the TSE-35 Index. Three years later, the American Stock Exchange released the S&P 500 Depository Receipt (called the SPDR or "spider" for short) in January of 1993 (Karmaziene & Sokolovski, 2017). It was very popular, and it is still one of the most actively-traded ETFs today.

An ETF is a pooled investment vehicle that tracks an index, as index fund as well as publically traded on stock exchanges, as a common stock. At their core, ETFs are hybrid investment products, with many of the characteristics of mutual funds with a feature of tradability like any common stocks (Groves, 2011). Like a mutual fund, an investor buys shares in an ETF to own a proportional interest in the pooled assets. Further, ETFs are generally managed by an investment advisor for a fee. But unlike mutual funds, ETF shares are traded in continuous markets on global stock exchanges, can be bought and sold through brokerage accounts, and have continuous pricing and liquidity throughout the trading day. Thus, they can be margined, lent shorted or subjected to any other strategy used by sophisticated equity investors (Hill et al., 2015).

However, Exchange Traded Products (hereafter ETPs) have experienced a surge in popularity and become a disruptive innovation ever since the invention of the first ETF; whereas the possibilities of their application has increased. At the end of 1993, there was only one ETF on the market, with assets of $464 million. By the end of 1997, there were still only two ETFs trading on the U.S. exchanges, with assets totalling $6.2 billion. Then the idea started to catch on. ETF issuance began to accelerate as more investment companies entered the marketplace (Ferri, 2011).

Mercado et al. (2017) report that Global ETP assets reached a new milestone in 2016 by ending at the $3.5 trillion mark, representing a YoY growth of 18%. The growth was mostly organic[7] with flows and asset prices increase representing 13%, and 5%, respectively. The authors further describe that during

[7] Organic growth is a term defined as the growth rate of an entity due to the increased output and enhanced sales.

2016, total inflows of $381bn were led by equities bringing in $249bn, followed by fixed income with $106bn, and commodity ETPs which also saw positive, albeit smaller, flows of $23bn. In 2016, the US ETP market led the inflow tally with an all-time high of $284bn, followed in the distance by the European and Asia-Pacific ETP markets with inflows of $55bn and 31bn, respectively. Meanwhile, the other markets (Rest of the World) attracted $12bn in net new assets.

BlackRock is a multinational company based in the US, with its renowned brand iShares. It is the largest ETP provider in the world with more than 763 funds and over USD 1,059 billion of Assets under Management (hereafter AuM). ETP industry grew worldwide from 106 products with USD 79,4 billion AuM in 2002 to 5,867 ETPs with USD 2,834.5 billion AuM in February 2016 (BlackRock Inc., 2016). This trend seems to continue as the industry grows across all markets and segments. Lower cost structure and the inability of almost all active funds to outperform indexes are the causes of the growth in the ETFs industry (Pisani, 2015).

2.3 Characteristics of ETFs

ETFs are now one of the fastest-growing segments of the investment management business. Exchange-traded funds provide liquid access to virtually every corner of the financial markets, allowing investors big and small to build institutional-caliber portfolios with management fees significantly lower than those typical of mutual funds. High levels of transparency for both holdings and the investment strategy help investors easily evaluate an ETF's potential returns and risks (Hill et al., 2015).

2.3.1 Cost saving

The cost savings come, first and foremost, since most ETFs are index funds and, therefore, do not bear the costs of discretionary, active portfolio management. The primary reason for ETFs' cost advantage is implied by their name: the funds are exchange traded (Hill et al., 2015) which is also explained by Bansal and Somani (2002) in their study that ETFs offer diversification and a cost-effective alternative to equity mutual fund.

2.3.2 Diversification

ETFs have created a wealth of new portfolio construction opportunities for a broad range of investors by opening up new asset classes for investing. Prior to the growth of ETFs, owning such assets as gold bullion, emerging market bonds, currencies, volatility, or alternative assets was difficult and costly except for large institutional investors. ETFs have made all areas of the capital markets accessible for any investor with a brokerage account (Hill et al., 2015). By owning shares of an ETF, the investor gets instant exposure to many securities, and this reduces the risk involved in owning individual securities (Woods, 2009).

2.3.3 Transparency

Most ETF providers display their entire portfolios on a daily basis through their websites, and this information is also picked up by financial data services. This transparency can be enormously helpful in portfolio construction and analysis (Hill et al., 2015). And ETFs are transparent because the fund manager discloses the underlying basket of shares to market every day and, unlike traditional funds, are not subject to style drift (Hehn, 2006).

2.3.4 Liquidity

ETFs can be bought or sold on secondary markets at various times throughout the day (Hill et al., 2015). According to Broman (2015) both individual and institution investors are attracted by the liquidity of ETFs. Hehn (2006) also described that ETFs typically offer strong liquidity and settle like any other share traded on the exchange.

2.4 Legal structure of ETFs

In order to comprehend ETFs as an investment vehicle, it becomes necessary to study the basic structures use to regulate different Exchange Traded Funds (Peyper, 2014). In the world of ETPs, there are essentially five asset classes and five legal structures under which these assets are traded. The five asset classes are equity, fixed income, commodity, currency and alternative. The five legal structures include Open-end Funds (OEFs), Unit Investment Trusts (UITs), Exchange-Traded Notes (ETNs), Grantor Trusts (GTs) and Limited Partnerships (LPs) (Wagner, 2012).

Table 2-1: Legal structures of Exchange-Traded Products

Legal Structures	Asset Class				
	Equity	Fixed Income	Commodity	Currency	Alternative

Open-end Funds (OEFs)	√	√		√	√
Unit Investment Trusts (UITs)	√	√			
Exchange-Traded Notes (ETNs)	√	√	√	√	√
Grantor Trusts (GTs)			√	√	
Limited Partnerships (LPs)			√	√	√

Table 2.1 illustrates the interplay between the asset classes and the legal structures of ETPs. Equity and Fixed Income ETPs can be structured as OEFs, UITs and ETNs. However, Commodity ETPs can be registered with regulatory body of the ETP's domiciled country (e.g. the US SEC) as ETNs, GTs and LPs. In case of Currency ETPs, beside UIT, the other four structures are applicable. Further OEFs, ETNs and LPs are the structures that can be used for Alternative ETPs.

According to Meziani (2016) ETFs are mainly registered as open-end investment company but there are few ETFs which are still unit operating with unit investment trusts (UITs) legal structure. Various structures of ETFs can lead to differences in how the products are managed and taxed, as well as how they manage risk and promote liquidity in portfolios (SPDR, 2015).

2.4.1 Unit Investment Trusts (UITs)

ETFs started as unit investment trusts before they took an open-end structure. The First ETF launched in the US (i.e. SPDR S&P 500 ETF) is the oldest and largest ETF which was (and remain) structured as UIT (Meziani, 2016). UITs do not have board of directors or investment advisers; they represent static investment portfolios, which are great for transparency and low costs (Levitt, 2016). UIT may not (1) hold securities that are not in the index, (2) reinvest cash received as dividends or (3) engage in securities lending or other "managed activities unlike open-end investment companies (Madhavan, Laipply, & Sobczyk, 2016). As of February 2016, there are just eight US ETFs which are structured as UITs including SPY, QQQ, MDY, DJA and four others.

2.4.2 Open-end Funds

ETFs are often structured as open-end investment companies, they are distinct from traditional open-end funds; ETFs limit redemption and list shares for intraday trading, which are features usually associated with closed-end funds (Grimm, 2008). As Bris, Goetzmann, Zhu, and Fabozzi (2004, p. 38) explains, ETFs "are a unique hybrid of closed-end and open-end investment companies," as they “trade like common stocks or closed-end funds” but can also be “redeemed like open-end funds,” albeit only in large aggregations of shares. Open-end fund structure allows the use of derivatives, portfolio sampling and securities lending. Dividends in these open-end funds are immediately reinvested and usually distributed to shareholders either monthly or quarterly. The open-end structure is used by major ETF issuers such as BlackRock, State Street Global Advisor and Vanguard (Deresky & Christopher, 2011).

2.5 Trading Mechanics of ETFs

2.5.1 Primary and secondary ETF market structure

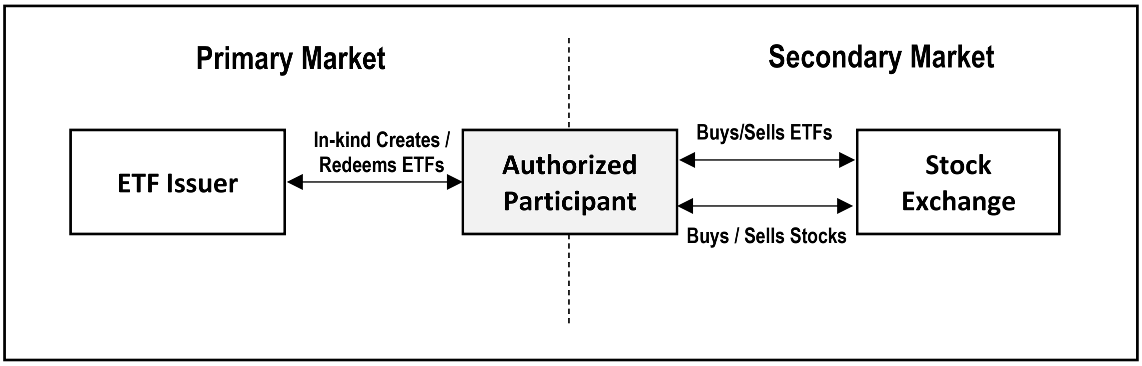

Figure 2-1: Primary and secondary ETF market structures

Figure 2-1 presents the primary and secondary market structure of ETFs. The creation/redemption of large block of ETF shares (of at least 50,000 ETF shares) carry out in the primary market while the buying and selling of ETF shares, in smaller quantities, which takes place in the secondary market (Peyper, 2014). The creation/redemption process illustrated in Figure 2-1 is referred to as “in-kind” and plays an important role in ETFs’ tracking of the benchmark index and tax efficiency.

2.5.2 Market participants

There are four main players involve in the creation and trading of ETF shares including ETF issuers, Authorized Participants (hereafter APs), Index Publishers and Stock Exchanges;

ETF Issuers

The ETF sponsor must license indices from index publishers (as necessary) for use in the context of an ETF, establish the legal infrastructure of these products, engage custodians (or authorized participants) to carry the creation units, and arrange for trading to be conducted on exchanges (Francioni & Schwartz, 2017).

Table 2-2: League of ETF Issuers, as of March 21, 2017

S#	Issuer	Asset Under Management ($ mm)	Net Fund Flow ($ mm)	% of AuM
1	BlackRock	1,077,401.31	2,431.22	0.23%
2	Vanguard	681,475.36	698.37	0.10%
3	State Street Global Advisors	535,291.86	895.01	0.17%
4	Invesco PowerShares	119,072.26	-654.85	-0.55%
5	Charles Schwab	68,733.99	37.04	0.05%
6	First Trust	44,681.19	25.96	0.06%
7	WisdomTree	42,485.86	-13.26	-0.03%
8	VanEck	35,149.11	-111.31	-0.32%
9	Guggenheim	34,478.02	25.54	0.07%
10	ProShares	27,028.45	-17.73	-0.07%

Source: ETF.com (2017a)

Table 2-2 presents the market share of largest providers of ETFs worldwide in 2016. BlackRock was the leading ETF provider in 2016 with highest AuM and highest daily net fund flow. Vanguard is the second major ETF provider in terms of AuM but its daily net fund flow is less than that of the State Street, the third major ETF provider. Invesco, WisdomTree, VanEck, Proshares despite having negative daily net fund flow remain in the top 10 list of ETF providers based on the values of their AuM.

Authorized Participants

In order to have shares to trade when the ETF goes public, the market makers provide the initial funding, known as seed capital. This would be in millions of dollars committed to a brand-new issue. The AP buys stock shares and exchange them with ETF shares ahead of the launch. This ensures there would be sufficient number of shares to trade when the ETF enters the market. In return, the market makers who provide the seed capital are designated as the authorized participants by the ETF Issuer to create and redeem ETF shares. This incentive provide APs a monopoly in trading and an unfair advantage over the other market makers (Carrel, 2008).

The only investors who can create or redeem new shares of an ETF are a special group of institutional investors called “authorized participants”. As the name suggests, APs are large broker/dealers, often market makers that are authorized by the issuer to participate in the creation/redemption process (Hill et al., 2015; Houweling, 2012; Smith, 2016). They buy large blocks of tens of thousands of ETF shares directly from the ETF provider in creation units. Similarly, they can sell such blocks to the ETF provider, in this case called redemption units. Creations and redemptions are mostly done in-kind, meaning that an authorized participant exchanges shares for a portfolio of securities held by the ETF. By this creation/redemption process, authorized participants act as liquidity providers in ETF shares (Houweling, 2012).

Prior to launch, the issuer will designate one or more AP to the fund. More can sign up over time. The most popular ETFs will have dozens of APs. An AP’s ability to create and redeem shares helps keep ETFs priced at fair value (ETF.com, 2017b). For example, if demand for an ETF increases and a premium develops, APs step in to create more shares and push the ETF’s price back in line with its actual value. If there is a rush to sell and a discount develops, APs buy ETF shares on the open market and redeem with the ETF issuers to reduce supply. Generally, the greater the number of APs for a particular ETF, the better. The force of competition is more likely to keep the ETF trading close to its fair value.

The task set forth for an AP is not necessarily an easy one. Sometimes the underlying market that they must access to change the supply of ETF shares is illiquid, or just difficult to access. An Exchange-traded product tracking the S&P 500 will be easy to access and easily hedge-able for most APs. Consider a Global X MSCI Nigeria ETF which targets the performance of MSCI All Nigeria Select 25/50 Index. Nigerian equity market is significantly less liquid in comparison to its developed counterparts and therefore APs with more specialized experience are suitable to look after these relatively less liquid markets and keep ETF prices close to its NAV (ETF.com, 2017b).

Index Publishers

In terms of structure, ETFs are designed to track the performance of a benchmark (mostly an index). Therefore, ETF Issuers require a license from Index Publishers for using an index as a benchmark for their ETF, e.g. the Lyxor (an ETF Issuer), which requires a license from FTSE Russell (an index publisher) to use the FTSE 250 Index as a benchmark for their Lyxor ETF FTSE 250 (Groves, 2011). The core business of the index publisher is to develop, maintain and license several type of traditional and factor indexes. Standard and Poor's, Dow Jones, MSCI and FTSE Russell are the largest indexers in the world (Wild, 2011). Almost two-thirds of the ETF industry's assets track benchmarks are provided by these four largest index publishers (Flood, 2016).

The Index Publishers charge a licensing fee from ETF issuers for using their index as the benchmark for ETF. The amount of a licensing fee is frequently not disclosed, but is based on a percentage of the assets in the ETF (Maeda, 2009) . Flood (2016) refers a statement of Joe Mansueto, CEO Morningstar, a data provider, regarding the monopoly of these handful Index publishers. He argues that these providers control the clear majority of the indexing market and they use their power to dramatically increase the licensing fees.

Some ETF issuers create their own in-house index to avoid licensing fees, but in this case, the regulatory authority (i.e. SEC) requires them to hire an outside fund manager to oversee the performance of ETF which is an additional expense (Maeda, 2009). These proprietary indexes are not solely build to save the licensing costs rather it also allows the ETF issuers to create unique product and help them to differentiate their investment strategies from other ETF issuers who invests in the indexes offered by Index Publishers (Flood, 2016).

Stock Exchanges

By definition, ETF is a tradable fund which can be bought and sold in the secondary market (i.e. at the exchange). Thus after getting the license from the Index Publisher, an ETF Issuer needs to fulfill all statutory requirements of listing an ETF in any exchange to make it available in the secondary market for trading (Groves, 2011).

In the beginning, most ETFs were traded on the American Stock Exchange (AMEX). However, in July 2005, BlackRock, one of the largest ETF issuer, decided to move its primary listings for 81 of its ETFs to the New York Stock Exchange (NYSE), citing superior technology. Then, in 2008, the AMEX was acquired by the NYSE, which today goes by the name NYSE Arca. As a result, more than 90 percent of all US-based ETFs today are listed on the NYSE Acra, with the remainder listed on the NASDAQ (Wild, 2011).

Carrel (2008) argues that ETF listings have been a growth business for the exchanges. The exchanges provide services to support the products in terms of trade execution, marketing, and index creation. In addition to the corporate index publishers such as Standard and Poor's, Dow Jones, MSCI, FTSE Russell, etc., the stock exchanges have witnessed the enormous revenue potential of index creation and licensing.

One ETF can be listed on multiple exchanges, such ETFs are called cross-listed ETFs. According to Atkinson and Green (2007) cross-listing gives investors the opportunity to expose to foreign securities that might not otherwise be available to them on a home exchange. It also increases the liquidity of the cross-listed security. Cross-listing of ETFs is very common in Europe and 68 percent of European ETFs are listed on two (2) or more stock exchanges (pwc, 2016). Wild (2011) explains that cross-listing makes it easy for the global ETF issuers to list their ETFs in any other country's stock exchange which already has listed elsewhere (in the US for example). Wild (2011) further added that most cross-listed ETFs track overseas indexes.

It is important to keep in mind the distinction between the market where an ETF trades, the jurisdiction under which it operates and the market that the ETF invests in (Groves, 2011). For example 'iShares Core S&P 500 UCITS ETF'[8] trades on the London Stock Exchange which is domiciled in Ireland and invests in the US.

2.5.3 Creation and redemption process

ETFs' new share creation process begins when an ETF Issuer files a plan with the exchange regulator to create an ETF. Once this plan has been approved, only authorized participants (generally market makers, specialists or large institutional investors) are permitted to create or redeem the ETF shares. ETF Issuer and AP can be the same party (Smith, 2016). In-kind or cash creation/redemption process is subject to the structure of ETF. Commonly, ETFs which hold the constituent securities of the tracking indices use in-kind process, however the ETF which use financial engineering to replicate the returns of their benchmarks use in-cash process. In-kind creation/redemption is generally practiced in the US market while cash creation/redemption process is widespread in the European markets (Charupat & Miu, 2013a).

[8] iShares Core S&P 500 UCITS ETF" is the complete name of an ETF (a single entity) which is referred as an example of an ETF which domiciled in one country, listed in another country and tracks the index of a different country.

In-kind Creation/Redemption Process

For the in-kind creation/redemption, the AP exchanges the shares for a corresponding basket of underlying securities (Osterhoff & Overkott, 2016). Once the authorized participant receives the ETF shares, they are sold to the public on the open market just like stock shares (Dolvin, 2010; Hill et al., 2015; Lempka & Stallard, 2013; McNally, 2001; Smith, 2016).

If the AP has a block of ETF shares to get rid of, the AP presents these shares for redemption to the ETF issuer and receives in return the basket of underlying securities, which the AP can then sell in the open market. This basket is often the same as the creation basket, but it may be different if the ETF is trying to get rid of a particular set of securities. The basket of securities the AP receives when it redeems shares is called the “redemption basket” (Hill et al., 2015).

Cash Creation/Redemption Process

For a cash creation/redemption, the AP delivers cash to the ETF management in return for a corresponding number of ETF shares. The management then allocates the money amongst its holdings, thereby investing the money in the respective underlying stocks (Osterhoff & Overkott, 2016). In certain cases, in-kind creation/redemption is difficult or nearly impossible, such as ETFs tracking non-U.S. benchmark indexes when the constituent securities are restricted from foreign ownership or when currency transactions taxes may be large. Cash creation/redemption is thus required as an alternative to the in-kind creation/redemption process. Additionally, in the case of leveraged ETFs, for which the leverage is obtained through the use of total return swaps, cash creations are the only option, since the fund holdings are over-the-counter derivatives contracts (Innealta Capital, 2012).

2.5.4 Arbitrage mechanism

The creation/redemption process creates an arbitrage limits for ETFs’ trading prices relative to the NAVs. If, for instance, the trading price of an ETF (which practices an in-kind process) is below its NAV, investors can create units of the ETF in the primary market and exchange them with underlying basket of securities in the secondary market, and earn, price difference (Charupat & Miu, 2013b).

Practically, the usefulness of arbitrage and the size of the arbitrage limits depend on various factors such as transaction costs, bid-ask spreads and the requirements related to creation/redemption process. Different ETFs has different rules, such as when to submit the creation/redemption order, how long is the settlement period, and what costs will be incurred. Risk of arbitrage transactions increase due to these difference in rules. Arbitrageurs can also be affected to hedge such risk. For instance, there is a cut-off time fixed for creation/redemption order submission for some ETFs, which is at noon on a trading day. Since creation/redemption is completed at NAV, which is estimated at the end of the day, price risk exists during this difference in time. The closer the cut-off time to the end of the day, the minimum the risk. (Charupat & Miu, 2013b).

According to the US Securities and Exchange Commission 2004 i.e. SEC (2004), an arbitrage opportunity is inherent in the ETF structure because the ETF's intraday market price fluctuates during the trading day. Due to this fluctuation, the ETF's intraday market price may not equal the ETF's end-of-day NAV. Authorized participants can arbitrage this difference (and make a profit) because they can trade directly with the ETF at NAV as well as on the market. The expected result of the arbitrage activity is that the market value of the ETF moves back in line with the ETF's NAV per share and investors can buy ETF shares on an exchange at a price that is close to the ETF's NAV per share.

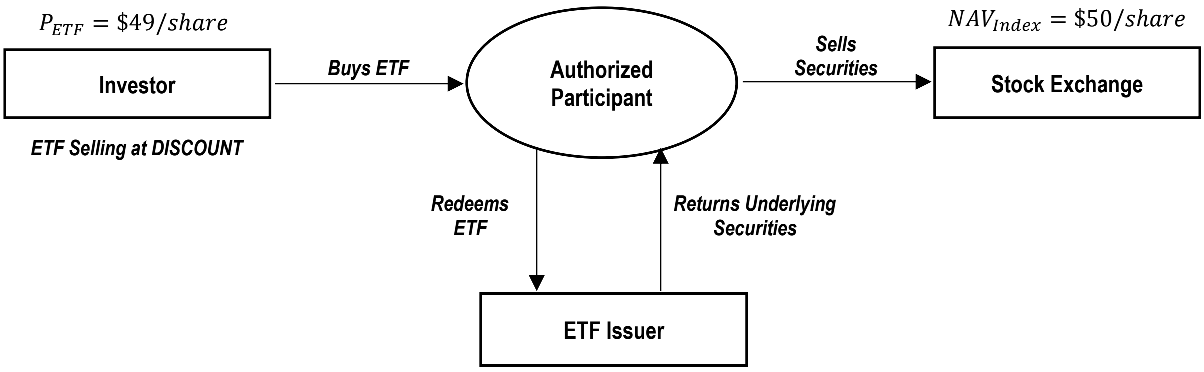

Figure 2-2: ETF trading at Premium

Source: (Ferri, 2011)

Figure 2-2 shows how the redemption process maintains the pricing efficiency of ETF shares. When ETF shares start to trade at a discount (i.e., a price less than NAV), AP purchases ETF shares in the secondary market. After accumulating shares equal a Creation Unit, AP redeems them from the ETF Issuer at NAV; and thereby acquires the more-valuable securities in the Redemption Basket. In purchasing the ETF shares, AP creates greater market demand for the shares, which may raise the market price to a level closer to NAV (SEC, 2004).

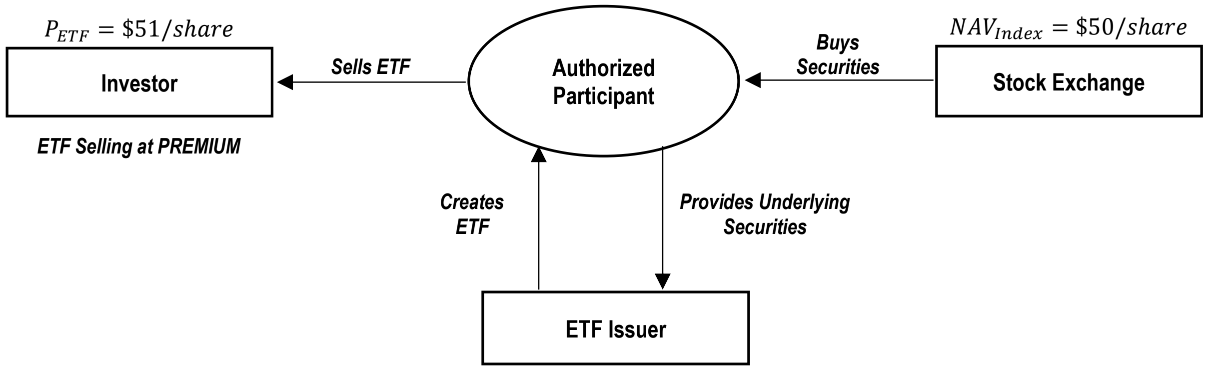

Figure 2-3: ETF trading at Discount

Source: (Ferri, 2011)

Figure 2-3 shows how the creation process maintains the pricing efficiency of ETF shares. When ETF shares start to trade at a premium (i.e., a price greater than NAV), arbitrageurs may purchase the securities in the Portfolio Deposit, use them to obtain the more-valuable Creation Units from the ETF and then sell the individual ETF shares in the secondary market to realize their profit (Ferri, 2011). As the supply of individual ETF shares available in the secondary market increases, the price of the ETF shares may fall to levels closer to NAV. An exchange specialist designated to maintain a market in the ETF shares also works to provide appropriate amounts of shares in the secondary market in response to supply and demand (SEC, 2004).

Although, the creation and redemption of ETF shares is typically in-kind (that is exchange of stocks and ETF shares) but ETF Issuers charge a small transaction cost, from the APs each time for creating and redeeming a unit of ETF shares. This transaction cost covers the fund's administrative expense and is very low compared to the total value of the unit (Beder & Marshall, 2011). The APs then pass this transaction cost onto the investors when they trade the ETF shares on the exchange (Haslem, 2009).

2.6 Replication strategies

The increased popularity of ETF products among investors has led to greater competition between ETF sponsors, forcing them to seek alternative replication techniques to optimise their fee structures. There are two main types of index replication strategies, namely physical and synthetic replication.

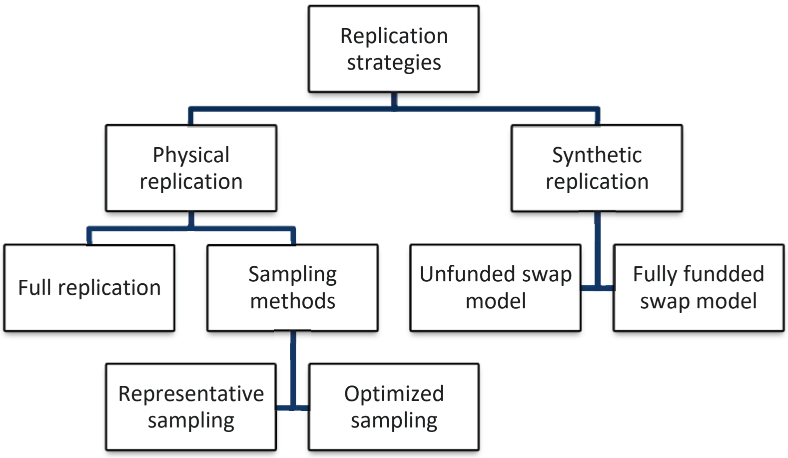

Figure 2-4: Classification of replication strategies

Source: Schar (2014)

Figure 2-4 illustrates hierarchy of replication strategies, primarily there are only two replication strategies, physical and synthetic replication strategies. Physical replication can be further divided into the full replication and the sampling methods, which furthermore comprises of the representative and optimized sampling. However, the synthetic replication strategies are categorised based on their swap models such as unfunded and the fully funded swap models.

2.6.1 Physical replication strategies

Full Replication

Full physical replication entails that the investment company purchases all constituent securities of the benchmark index (Naumenko & Chystiakova, 2015), in the same proportions, for inclusion in the tracker. An ETF on the S&P 500 index managed physically, for example, would include all 500 securities in order to reproduce all index events. Transparency is the principal advantage of this technique, as the investor knows with certainty the nature of his/her investment and can see the composition of the fund on a daily basis. The drawback of complete physical replication is the necessity for the fund manager to modify regularly the composition of the tracker following index rebalancing (Maurer & Williams, 2015).

Replication by Representative Sampling or Optimization

As full physical replication is relatively expensive in terms of additional commissions, especially for broad indexes composed of hundreds of stocks or for some emerging market indexes containing illiquid components, many sponsors attempt to optimize their cost structure through a variant of full replication (Maurer & Williams, 2015). Representative sampling, or optimization, used in cases where full replication is neither cost-effective nor necessary to reproduce the underlying, resorts to investing in only a fraction of the constituent securities (Davidson & Wild, 2012). The choice of relevant securities for inclusion in the tracker depends on their market capitalization, as well as fundamental and sector-based criteria, to arrive at an optimal basket

2.6.2 Synthetic replication strategies

Synthetic replication strategy uses to transfer the risk of any deviation in the ETF's return from its benchmark to the swap provider, which is affected by entering into a derivatives contract to receive the total return of the benchmark (Omondi, 2016; Ramaswamy, 2011).

Physical replication strategy is advantageous if the ETF tracks the large and liquid indices such as the S&P 500 or EuroStoxx 50 because they are easy and efficient to replicate. But if the underlying indices are illiquid and difficult-to-track then physical replication strategy can be very expensive despite some optimization may be employed. In such instances, where the underlying index is either illiquid or difficult-to-track, synthetic replication is quite effective; as the index can be tracked far better than the traditional (i.e. physical) replication strategy (Raab & Stahn, 2017).

ETFs are designed to mirror the performance of their underlying index (Rompotis, 2011a) and if any ETF fails to exactly replicate the return of underlying index, it exposes investor to the tracking error risk. In physical ETFs, the source of tracking error is the extent of a portfolio's index replication; the more a portfolio is 'optimised', the less likely it is to consistently track an index (Dickson, Mance, & Rowley Jr., 2013). Whereas, in case of synthetic ETF, the underlying index return is guaranteed by the counterparty and errors caused by the inexact replication are not an issue. However synthetic ETF exposes investors to the counterparty risk which refers to the failure of the counterparty to fulfil its obligation of delivering the performance of the tracking index.

Synthetic replication protects investors from the tracking error risk which physical replication strategy would otherwise expose them to. Hurlin, Iseli, Pérignon, and Yeung (2016) establish that counterparty risk exposure is higher for synthetic ETFs but it is compensated through lower tracking errors. Similarly, Elia (2012) also confirms that synthetic ETFs have lower tracking error than that of physical ETFs. Thus the investors always face a trade-off between physical and synthetic ETF to reduce the tracking error for illiquid or difficult to track indices at the cost of increased counter party risk.

Unfunded Swap Model

The unfunded swap model was the first method used in the Europe to synthetically track the performance of an index. Figure 2-5 shows the process on how a synthetic replication operate using an unfunded swap model. Under this structure, the ETF uses cash from investors to buy a basket of securities from a swap counterparty (often the provider's parent bank) who commits to deliver the performance of a reference index (less swap fees where applicable) in exchange for the performance of the securities bought by the fund (Johnson et al., 2012; Ramaswamy, 2011). The assets bought by the fund, which are often referred to as 'fund holdings' or 'substitute basket', typically do not include the constituents of the reference index but can have high degree of correlation with them (Johnson et al., 2012).

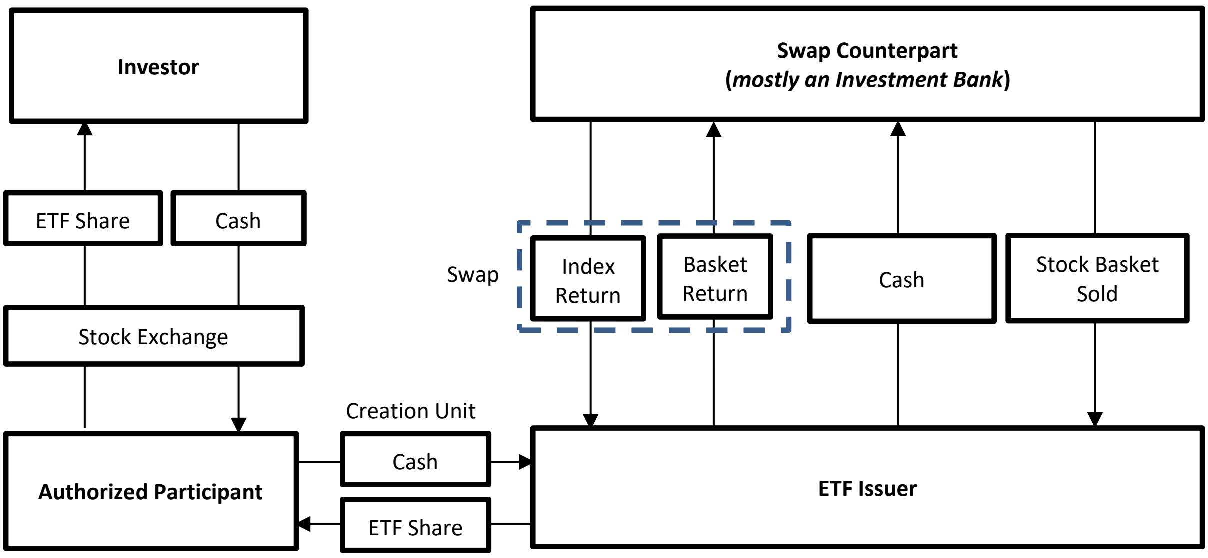

Figure 2-5: Unfunded Swap Model

Source: Ramaswamy (2011)

Counterparty risk refers to the possibility that the party providing the swap fails to fulfil its obligation to deliver the performance of the assets being tracked. Net counterparty exposure is measured as the difference between NAV of the ETF and the value of the substitute basket (in other words, the swap mark-to-market) (Hurlin et al., 2016).

To mitigate counterparty risk, the regulatory authorities of the relevant countries stipulate that exposure to a swap counterparty may not exceed a certain limit (e.g. in Europe, UCITS limits the exposure to 10% of the fund's NAV (Amenc, 2012)). In other words, the daily NAV of the substitute basket should amount to a maximum (e.g. 90% of the ETF's NAV in case of Europe). This means that, if the swap counterparty defaults, the fund holders should be able to recoup the maximum of the ETF's NAV prevailing at the time of default.

Funded Swap Model

The funded swap model was introduced in Europe in early 2009. Figure 2-6 elucidates the process on how a synthetic replication operate using funded swap model. Under this structure, the ETF does not use investors' cash to build a substitute basket—as is the case of ETFs which use unfunded swaps. Instead, the fund transfers investors' cash to a swap counterparty in exchange for the index performance (less swap fees) plus the principal at a future date (Johnson et al., 2012; Ramaswamy, 2011). The counterparty posts collateral assets in a segregated account with a third-party custodian. The account can be held either in the name of the fund or in the name of the counterparty and pledged in favour of the fund (Aggarwal, 2012).

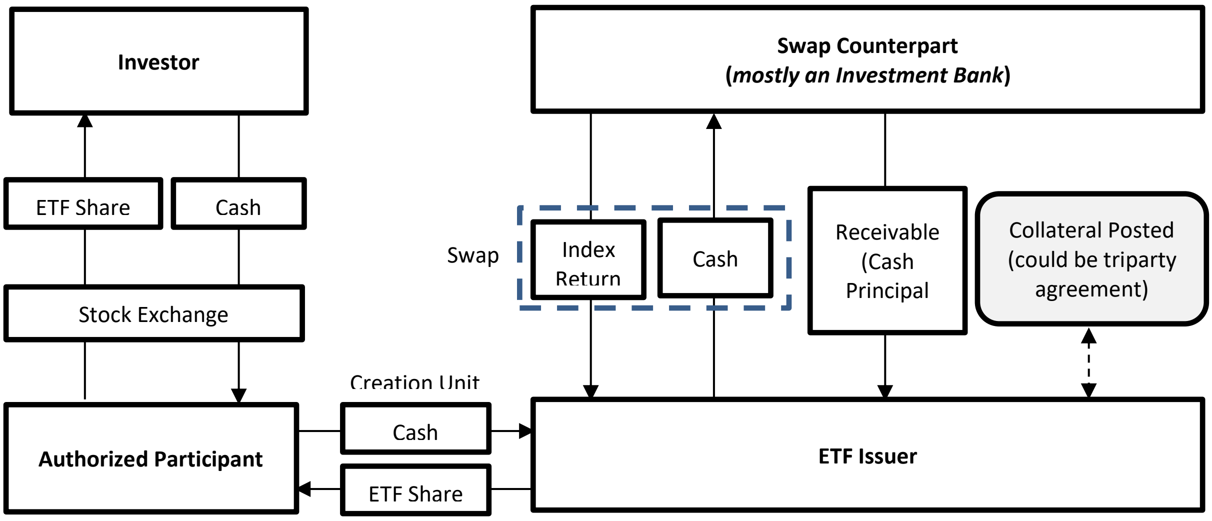

Figure 2-6: Funded Swap Model

Source: Ramaswamy (2011)

In case of funded swap model, net counterparty exposure is measured as the difference between the fund's NAV and collateral value (less haircuts or margins). For example, in Europe, under UCITS, the net counterparty risk exposure may not exceed 10% of the fund's NAV, which means that at least 90% of the ETF must be collateralized. There would be no counterparty risk if the fund is fully collateralized, i.e. that collateral value (less haircuts or margins) is equivalent to 100% of the fund's NAV (Hurlin et al., 2016). In all cases, whenever the collateral value falls below the level of collateralization agreed with the swap counterparty, additional collateral will be requested. This is to ensure that the agreed-upon level of collateralization is maintained at the end of each business day (Amenc, 2012).

With a transfer of title, the collateral is treated as the property of the fund. This means that if the swap counterparty defaults, in theory, the ETF provider should be able to gain access to the assets without prior approval and dispose off them. Under a pledge structure, the fund would have to claim ownership of the collateral assets before it can sell them (Orlando, 2013).

2.7 Types of ETFs

2.7.1 Physical and synthetic ETFs

In terms of replication methodology, there are two types of ETFs: Physical ETFs and Synthetic ETFs. A Physical ETF invests in securities that replicated or represents the composition of the index it tracks, and a Synthetic ETF uses financial derivative instruments use financial engineering to achieve the desired results (Naumenko & Chystiakova, 2015).

2.7.2 Actively-managed and Passively-managed ETFs

Traditional ETFs, in their original incarnation, mirrored various equity market indices so they are passively-managed ETFs on the contrary actively-managed ETFs do not seek to replicate the performance of a particular market index; rather, they seek to outperform their benchmarks through active portfolio management (Rompotis, 2013a). Actively-managed ETFs will invest in a portfolio of securities that is subjectively chosen by a fund manager rather than follow a rule-based index. The idea is to perform better than an index through active management. And, for their supposed investment skill, actively managed ETFs will likely charge a higher fee than ETFs that follow indexes.

2.7.3 Leveraged and Inverse Leveraged ETFs

The leveraged ETFs are aimed at beating the underlying benchmarks and are designed to deliver twice or three times the performance of the benchmark over a pre-specified period (before fees and expenses), which usually does not exceed the one day. The inverse ETFs seek to short the market and provide performance opposite to various market benchmarks on a daily basis (Rompotis, 2014). Leveraged and Inverse ETFs are principally designed to achieve daily returns, their long-term performance is likely to deviate from the long-term performance of their respective underlying indexes.

2.7.4 Domestic and International ETFs

Domestic ETFs give investor an exposure of domestic security indices (Australian Securities Exchange, 2013a) only but global ETFs follow indexes that cover the entire globe as well as the international component, regional components, and individual country components (Australian Securities Exchange, 2013b). Most international ETFs (global, regional or single country) are domiciled and listed in the US, then made available for trading in any country. The issuers of international ETFs are large financial institutes that are able to take advantage of their existing infrastructure and investing arrangements to run their ETFs cost-effectively from the US. They build their broad indices from the country level up, which means countries are lumped together into regions, regions are lumped together to form international indexes, and international indexes are combined with the U.S. indexes to form global indices (Ferri, 2011).

2.8 Conclusion

This chapter introduces ETFs providing a comprehensive discussion from the evolution to revolution of this most successful innovation of the financial industry. The proliferation of ETFs is evidenced by the thousands of such products launched in the stock markets worldwide during the past two decades and the trillions of US dollars globally invested in these products. The success of ETFs is based on their unique features and the plethora of choices that they provide to investors. This chapter summarizes the trading characteristics and the benefits offered to investors by ETFs. In particular, the low costs, trading flexibility, tax efficiency, high liquidity, wide risk diversification and transparency of ETFs are discussed justifying the spectacular popularity of ETFs with investors.

The chapter also provides a discussion of the various replication strategies used to replicate the benchmark return by ETFs. These strategies and types of ETFs enable retail and institutional investors to not only get the exposure of domestic indexes but also the exposure of foreign indexes in domestic currency. An introduction to the wide variety of the types of ETFs based on various asset classes, themes, sectors, geographic focus, leverage, and investment styles is also provided in this chapter. The chapter also discusses the legal structure based on which the ETFs are developed and operated in the financial markets. Working mechanism, creation and redemption process and arbitrage process are also explained in this chapter. In summary, this chapter provides an ample introduction and background of ETFs.

Chapter 3

Literature review

3.1 Introduction

Chapter 3 reviews the important literature related to this study. Section 3.2 explains the RWH and its three different versions; it also discusses the empirical evidences of non-random behaviour of asset returns in different markets and the factors associated with the rejection of RWH. Section 3.3 describes the calendar anomalies in the asset returns and the possible explanations associated with each type of calendar anomaly. It also explains the EMH and its contradiction with calendar anomalies. This section also provides a discussion on the AMH which provides an intellectually consistent explanation of the co-existence of EMH and market inefficiencies. Section 3.4 presents a comparative discussion on the returns and volatilities estimated in trading price and NAV of ETFs. Section 3.5 discusses the distinguishing intraday and overnight volatility behaviour of assets. Section 3.6 describes the risk-adjusted performance of ETFs compare to their benchmark indices. Section 3.7 explains the tracking ability and the persistence of tracking error. Section 3.8 discusses the trading pricing deviation of ETFs from its NAV and explain its persistence over time. Section 3.9 concludes chapter.

3.2 Random walk

RWH has practical implications on examining the financial models of International ETFs. First, RWH implies that securities return follows a random walk and if it does not, the findings based on it are questionable (Pan et al., 1997). Second, RWH also implies that the security prices fully reflect all available information precluding arbitrageurs to exploit the mispricing on consistent and long-term basis. Moreover, Samuelson (1965) argues that the return generation process in the informationally efficient market are random and driven by unforeseen events and cannot be predicted based on the historical returns. Therefore, any information asymmetry in the market significantly affects the pricing efficiency of the security.

Early definitions of RWH are too restrictive to capture the real world phenomena. Therefore Campbell et al. (1997a, pp. 27-33) explain three different versions of RWH based on the conditions incorporating the idea of returns movement ("walk") in an unpredictable ("random") manner. The first version of RWH requires independently and identically distributed (iid) residuals of the autoregressive model of ETF returns. The second version of RWH is relatively less restrictive and permits unconditional heteroscedasticity in the residuals. To put it another way, time-varying fluctuation permits in any form provided that the residuals are independent. The most relaxed and general version of all the three versions of RWH is the third version which only ask for the residuals to be independent.

The literature on RWH is abundant and findings are either in favour or in contrast to RWH. Moving ahead, the results against the RWH indicates the presence of autocorrelation in the return series and could further results in positive or negative autocorrelation. *Positive autocorrelation* shows that returns partially adjust to their intrinsic values because of the non-synchronous trading, risk premium, and market frictions (Koutmos, 1998, 1999). However, *negative autocorrelation* reveals the mean-reverting behaviour of the return series. De Bondt and Thaler (1985, 1987) argue that mean-reversion occurs in response to the irrational overreaction of market participants to the shocks of securities returns. Identifying the presence of positive and negative autocorrelation is very important to investors for carving suitable investing strategies. According to Farmer and Joshi (2002), investor prefers *trend following strategy*[9] in the case of positive autocorrelation and *value investing strategy*[10] for negative autocorrelation.

We discuss some selective literature on RWH in different geographical context such as Middle Eastern, Asian, Latin American and the European stock markets. Among the studies with geographic focus of Middle Eastern markets, previous studies (Abraham et al., 2002; Benjelloun & Squalli, 2008; Smith, 2007) did not find evidences in favour of RWH in context of Kuwait, Saudi Arabia, Bahrain and Oman stock markets but in stock market of Israeli, Jordanian and Lebanese Smith (2007) find evidences in favour of RWH. Thin trading is considered as the detrimental factor resulting the rejection of random walk in the Middle Eastern markets (Abraham et al., 2002; Butler & Malaikah, 1992).

Along similar lines with geographic focus of Asian markets, Husain (1997) in Pakistan, finds no evidence of return independence and Mustafa and Nishat (2007) consider thin trading, as the main reason. Ayadi and Pyun (1994) find returns as linearly dependent on the past returns in Korean market. However, the returns of Chinese and Indian stock markets follow random walks, as cited by Liu, Song, and Romilly (1997) and Sharma and Kennedy (1977), respectively.

In the context of Latin American countries, Urrutia (1995) examines monthly index returns of the equity markets and finds positive correlation in return series but some other studies find inconsistent

9 Trend following strategy - buy when the price of asset goes up and sell when it goes down
10 Value investing strategy - buy when the asset is undervalued and sell when it is overvalued.

results. The studies by Grieb and Reyes (1999) and Smith, Jefferis, and Ryoo (2002) report significant evidences of random walk in equity returns of Brazilian and South African markets, respectively, but they fail to find any significant result favouring RWH for any other market in their sample.

The returns of emerging market in Europe also behave similarly and does not follow random walk in general. Jennergren and Korsvold (1974) attempt to examine the random walk of 45 Norwegian and Swedish listed equities and found no significant results in favour of RWH. In another study by Frennberg and Hansson (1993), the authors report significant serial correlation in Sweden listed stock returns. Borges (2011) investigates RWH in stock returns of France, Germany, the UK, Spain, Greece and Portugal and not so surprisingly, the author found that besides Greece and Portugal, the returns of all other market follow random walks. Solnik (1973) observes the inefficiency of European capital markets and the possible causes include thin trading, insider trading and inadequate disclosure norms.

Majority of previous empirical literature concentrated on testing the random walk characteristics of stocks and indices. Only a few studies attempted to investigate the randomness of relatively new financial instruments such as ETFs. One such study is Rompotis (2011b) who investigated the daily return series of a range (i.e. Broad, International, Sector) of 66 US-listed ETFs for the period 2001-2010 and found that EMH holds in the ETF market. The author's finding might hold true for regular ETFs but not for the exclusive case of international ETFs because most of the US-listed international ETFs track the performance of foreign markets with non-synchronous trading hours with the US. And this non-synchronous trading hours cause international ETFs to suffer from information asymmetry and ineffective creation/redemption issues, the two likely reasons why international ETFs do not follow the random walk.

Despite abundant literature on the RWH, there is no consensus on market efficiency among the researchers. Different statistical tests yield different results. Conventional tests mostly exhibit random walks in the return series. The factors mainly associated with the rejection of RWH are non-synchronous trading, inadequate disclosures, regulatory restrictions, and limited reforms.

3.3 Calendar anomalies

Monday effect

An extensive literature documents that weekday returns vary with the day of the week (day-of-the-week-effect). One of the most documented is the tendency for asset returns to be negative on Mondays, which was first documented by market practitioners and then academics. Maberly (1995) shows that financial practitioners were aware of the Monday effect as early as the late 1920s, with the first documented finding by Kelly (1930) who found Monday to be the worse day to buy stocks from a three-year statistical study. The first academic to document the Monday effect was Cross (1973), who studied the S&P 500 from 1953 to 1970. Over this period, the index advanced on 62% of the Fridays and had a mean value of 0.12%. On Mondays however, the index advanced only 39.5% of the time, and the mean was −0.18%. Cross also found that the performance on Monday was dependent on the pervious Friday's performance. French (1980) studied the S&P 500 from 1953 to 1977 and found day-of-the-week evidence in the US stocks, including negative and statistically significant Monday returns. Gibbons and Hess (1981) also documented similar results when studying the S&P 500 and CRSP value- and equally-weighted indexes from NYSE and AMEX securities from 1962 to 1978, as did Keim (1987) for the US indexes from 1963 to 1985.

Lakonishok and Smidt (1988) extend the sample size by conducting a ninety-year study on weekday returns for the DIJA. They report negative Monday returns for the entire sample (1897−1986) and for each of their selected subsamples, with average Monday returns significantly less than zero for all but two of the subsample periods. Furthermore, Schwert (2003) documented the weekend effect in the US from 1802 to 1987 and Siegel (1998) furthered these findings by examining the Monday effect over the period 1885 to 1997. The author concludes that if Monday returns had been equal to the average of non-Mondays over this entire sample period, the DJIA would be almost twice its level as it was at the end of 1997.

The Monday effect was one of the first calendar anomalies to be discovered and the previous evidence suggests that it has been quite strong. However a number of studies have found that it has diminished and in some cases even reversed over time. Connolly (1989) finds that Monday returns were significantly different from non-Monday returns before 1974, but were not significantly different after 1974, although they remained negative. These results were confirmed by Chang, Pinegar, and Ravichandran (1993) while Kamara (1997) reports that the Monday effect has diminished significantly since the introduction of the S&P500 futures contract in 1982. Marquering, Nisser, and Valla (2006) studied the DJIA from 1960 to 2003 and found that the Monday effect has declined in recent years.

While some studies find the weekend effect diminishing, a number have seen a complete reversal in returns. Brusa and Pu (2000) discover that Monday returns for large US stocks were positive and the largest of any day of the week during the 1990s. Mehdian and Perry (2001) confirm this 'reversal' in returns for large US stocks from November 1987 to August 1998, although they did find a persistent negative Monday return for small stocks. Brusa and Li u (2004) document that this reversal in returns is concentrated on positive returns in the first and third weeks of each month, while Brusa, Pu, and Schulman (2005) find that the positive weekend returns are correlated with the previous Friday's return, suggesting that the positive Monday returns are likely to be observed after a positive Friday return. Doyle and Chen (2009) examine 11 major stock markets over the period 1993–2007 and report a wandering weekday effect, where the day of the week showing systematically higher or lower returns is very sensitive to the choice of sub-period. Boudreaux (1995) study the Monday effect in the DJIA, S&P500 and the NASDAQ during the sample 1976–2002. By breaking their samples in bear and non-bear market periods, they find evidence of a weekend effect with weekend returns being greater than non-weekend returns only in non-bear markets. They attribute this finding to a wealth effect where as stock prices rise, investors gain confidence and are more likely to act upon broker recommendations during the week. Alt, Fortin, and Weinberger (2011) examine the Monday effect in the US, the UK and German stock markets using a test procedure based on the closure test principle that controls for multiple type I errors. They find a Monday effect in the 1970s and 1980s, while it appears to have vanished in all three markets in the 1990s and 2000s in all three markets.

Potential explanations for Monday effect

Information Processing Hypothesis: Miller (1988) and Lakonishok and Maberly (1990) argued that although it is costly for all the investors to gather and process information, it is particularly costly for the individuals to do so during weekday trading hours when these people are employed in other activities. For individual investors weekends provides a convenient, low cost opportunity to reach at investment decisions. Therefore, when market reopens the individual investors might be expected to be more active. Although, they may put some buying orders during other days of the week based on the recommendations of stock brokers, but for selling orders they rely on their own analysis. Therefore, the selling pressure exceeds the demand on Monday. On the other hand, the trading volume of institutional investors remains depressed on Monday morning. Osborne (1962) explained that decrease in institutional trading activity is a consequence of an industry- wide practice of using the early trading hours of Monday as an opportunity to plan strategy for the upcoming week.

Information Release Hypothesis: French (1980), Rogalski (1984), DeFusco, McCabe, and Yook (1993) and Damodaran (1989) show that firms trend to report bed news on weekends (Friday) and this delayed announcement of bad news might cause the negative Monday effect.

Settlement Regime Hypothesis: Gibbons and Hess (1981) and Lakonishok and Levi (1982) reported that the delay in the cash payment for the security can lead to enhancements in the rates of return on specific day due to the extra credit occasioned by the two days of the weekend.

Trading Activities of Investors: Osborne (1962) suggested that individual investors have more time to make financial decisions during the weekend; they are relatively more active in the market on Monday. The author also reported that institutional investors are less active in the market on the Monday because Monday tends to be a day of strategic planning.

January effect

The January effect states that returns in January appear to be higher than in other months of the year. It was first documented by Rozeff and Kinney (1976) and has gained much attention from academics as well as practitioners. Rozeff and Kinney (1976) study the NYSE for the period 1904 to 1974 and find that the average return for the month of January was 3.48% compared to only 0.42% for the other months. Keim (1983) also employs the NYSE from 1963 to 1979 and found that nearly 50% of the average magnitude of the risk-adjusted premium of small firms relative to large firms is due to January abnormal returns. The author also found that 50% of the January premium is due to abnormal returns during the first week of trading in the year. Roll (1983) and Reinganum (1983) support these findings for small firms, and particularly for small firms with low share prices. Kohers and Kohli (1991) however, provide evidence that the January effect is not related to the small firm effect. Nevertheless, high returns are not found in an index that is composed of only large firms, like the DJIA. Lakonishok and Smidt (1988) find no evidence of the January effect in the DJIA for the whole of January, and only find mild support for rates of return being larger in the first half of the month than in the last half. Gultekin and Gultekin (1983) use data from some 17 countries including the UK and Japan for the sample period 1959 to 1970 using the Capital International Perspective (CIP). This is an index that provides monthly stock market returns based on 1110 share prices and counts for approximately 60% of the total value of all shares traded in the countries examined. They find that returns in January and April are significantly high for the UK but just in January in Japan. The January effect is evident for all countries and they attribute the abnormal returns to the turn of the tax year. Kato and Schallheim (1985) examined excess returns in January for the Tokyo Stock Exchange. They find excess returns in January and a strong relationship between return and size, with the smallest firms returning 8% and the largest 7%. Similarly, Mills and Coutts (1995) study the January effect for the FTSE100, Mid 250 and 350 Indices from January 1986 to October 1992. They find evidence supporting the January effect, with daily returns positive and significant for January and February in the FTSE100 and for January in the Mid250. Sun and Tong (2010) find strong evidence of the January effect in monthly CRSP data from1926 to 2005 and conclude that the effect is not due to risk.

Although there has been strong empirical evidence in favour of the January effect, recent research has argued that the magnitude of the anomaly has declined. Riepe (1998) states that during the 1980s and 1990s there was an increase in general knowledge about the January effect and the emergence of futures contracts. This resulted in a low-cost alternative for investors to profit from the effect. Consistent with this, Mehdian and Perry (2002) suggest that the January effect has disappeared in the US. They study the DJIA, NYSE and S&P500 and find that from 1964 to 1987 January returns are positive and significant for all three stock markets. However after 1987, the January returns are positive but not significant, thus indicating that the anomaly has disappeared. Similarly, Gu (2003) uses a power ratio of the mean returns in January compared to the mean return of the year. The author’s results show that both large and small firm stock indices have declined since 1988 and they have disappeared for the Russell indices. The declining trend is also evident in the Dow 30 since 1930. However, these two studies use monthly returns while using daily returns may give a more accurate picture of the evolution of stock prices. Marquering et al. (2006) also find that since the January effect was discovered in 1976, it has diminished and seems to have disappeared at the start of the 21st century. Moller and Zilca (2008) examine daily data of the NYSE, AMEX and NASDAQ from 1927 to 2004 and conclude that the magnitude of the January effect has not declined. However, they did not find higher abnormal returns in the first part of January and lower abnormal returns in the second part of January in their subsample 1995 to 2004. These returns offset each other, thus the overall magnitude of the January effect appears similar to its magnitude in the previous 1965–1994 period. Jacobsen and Zhang (2013) examine over 300 years of UK stock returns and find that the January effect only emerges around 1830, which coincides with Christmas becoming a public holiday but is no longer significant from 1951 to 2009. However, Beyer, Garcia-Feijoo, and Jensen (2013) monthly stock returns from June 1963 to December 2010 show that a portfolio composed of small, out-of-favour stocks outperformed the market average 45 of the 47 Januaries, and that after controlling for relevant factors, there is no evidence suggesting that the January effect has diminished since it was widely publicized in the 1980s.

Potential explanations for January effect

Tax-Loss Selling Hypothesis: One of the explanations put forward for the existence of seasonality in stock returns is the 'tax-loss-selling hypothesis. This hypothesis was first suggested by Branch (1977). According to the hypothesis, investors want to realize capital losses in current tax year, which create a downward price pressure at the year-end on securities that have previously experienced negative returns. Subsequently, at the beginning of the new tax year, this selling pressure is relieved and the affected securities earn excess returns as their prices rebound. For example, in many countries, December is the tax month; therefore, the financial houses sell shares whose values have fallen, to book losses in order to reduce their taxes. As a result of this selling, stock prices decline. However, as soon as the December ends, people start acquiring shares and as a result stock prices bounce back. This lead to higher returns in the beginning of the year, that is, in the month of January. This is called the 'January effect'. Evidence in support of this hypothesis is provided by Jones, Lee, and Apenbrink (1991) and Poterba and Weisbenner (2001). Contradicting evidences are also abundant. Brown, Keim, Kleidon, and Marsh (1983) in Australia and Kato and Schallheim (1985) in Japan report significant January effects, even though January is not the beginning of the tax year in those countries.

Window Dressing Hypothesis: According to the window-dressing hypothesis, developed by Haugen and Lakonishok (1988), the institutional investors sell their loss making shares and buy profit making shares at the end of the calendar year so that they could avoid showing the loss making shares in their reports and maintain respectable position in the market. Institutional managers are evaluated based on their performance and their investment philosophy. To improve their performance, the institutions buy both risky stocks and small stocks (as profit can be increased by taking extra risk) but sell them before the end of the year so that they do not show up in their year-end holdings. At the beginning of the calendar year, investment managers reverse the process by selling winners, large stocks, and low risk stocks while replacing them with small and risky stocks that typically include many past losers. The window dressing hypothesis represents an alternative but not necessarily an exclusive explanation for the month-of-the-year effect.

Information Release Hypothesis: Rozeff and Kinney (1976) reported that good news is released in the first few days of January; therefore, the returns are high at the beginning of the year. Berry and Brown (1985) found that relative information of poor securities have more systematic risk than that of rich securities. At the end of the year flood of news make small capitalized stocks much active than large capitalized stocks which are already rich in information. Consequently, small stocks would react more strongly to the increased flow of news in the month of January by generating larger returns than the large stocks. Penman (1987) finds that firm release good news in the beginning of each quarter and bad news release in second half of the quarter.

Parking the Proceeds Hypothesis: This hypothesis is suggested by Ritter (1988). He argued that the month-of-the-year effect is caused by the buying and selling behavior of individual investors. Parking the proceeds hypothesis can be viewed as a generalization of the tax loss selling hypothesis. As at the end of the year, individual sell securities in order to realize the losses for tax purpose. Some of the proceeds from the sale are not immediately reinvested but "parked" until January and then invested which pushes up the demand and consequently the prices of securities.

Small Firm Effect Hypothesis: There has also been an explanation linking the January effect with the small firm effect. Keim (1989) attribute this to microstructure biases. According to this explanation, the last trade in December for most stocks is at the bid price, which causes returns to appear high in the first few days of January. Keim (1989) found that the tendency for stocks to be at the bid price for the last trade in December was much pronounced for small stocks. In addition, small stocks have higher bid-ask-spread and a lower price. Therefore, the return would be bigger for small stocks and this partly explains the differences in the January effect between large and small stocks.

Market Efficiency

There are two schools of thoughts on the efficiency of financial markets i.e. the efficient markets school and the behavioural finance school. The proponents of first school advocate the EMH while the later school support AMH.

The origins of the EMH can be traced back to Samuelson (1965), whose contribution is neatly summarized by the title of his article: "Proof that Properly Anticipated Prices Fluctuate Randomly". In an informationally efficient market, price changes must be unforecastable if they are properly anticipated, i.e., if they fully incorporate the information and expectations of all market participants. Roberts (1967) and Fama (1970) operationalized this hypothesis - summarized in Fama's well-known epithet "prices fully reflect all available information" - by placing structure on various information sets available to market participants.

The more efficient the market, the more random the sequence of price changes generated by such a market, and the most efficient market is one in which price changes are completely random and unpredictable. This is not an accident by nature, but is in fact the direct result of many active market participants attempting to profit from their information. Driven by profit opportunities, an army of investors pounce on even the smallest informational advantages at their disposal, and in doing so, they incorporate their information into market prices and quickly eliminate the profit opportunities that first motivated their trades. If this occurs instantaneously, which it must in an idealized world of “frictionless" markets and costless trading, then prices must always fully reflect all available information. Therefore, no profits can be garnered from information-based trading because such profits must have already been captured.

Grossman (1976) and Grossman and Stiglitz (1980) went further. They argue that perfectly informationally efficient markets are an impossibility, for if markets are perfectly efficient, there is no profit to gathering information, and there would be little reason to trade and markets would eventually collapse. Alternatively, the degree of market inefficiency determines the effort investors are willing to expend to gather and trade on information, hence a non-degenerate market equilibrium will arise only when there are sufficient profit opportunities, i.e., inefficiencies, to compensate investors for the costs of trading and information-gathering. The profits earned by these attentive investors may be viewed as “economic rents" that accrue to those willing to engage in such activities. Who are the providers of these rents? Black (1986) gave us a provocative answer “noise traders", individuals who trade on what they consider to be information but which is, in fact, merely noise.

The proponents of AMH, on the other hand, brought evidence from behavioural finance and psychology showing that investors, especially retail traders, exhibit irrational behaviour in making investment decisions, i.e., asset allocation and portfolio construction, which can explain the observed violations of the EMH in capital markets. Lo (2004) surveyed the literature on the debate between the advocates of the EMH and behavioural finance and suggested a reconciliation between both approaches. His reconciliation hypothesis, which he called "the Adaptive Markets Hypothesis", posits that market inefficiency is due to irrational behaviour of investors. But since investors adapt to the changing environment, their adaptability over time brings the market back to efficiency. Basically, Lo’s AMH posits that financial markets transit between episodes of inefficiencies, but the adaptability of its participants continuously forces them to revert back to efficiency.

The AMH has been studied in some detail in the recent literature through a variety of testing procedures. Lim (2007) study eleven emerging and two developed markets using the portmanteau bicorrelation test through a rolling sample framework and find that market efficiency evolves over time in a way consistent with the AMH. Ito and Sugiyama (2009) measure the degree of time varying market efficiency of monthly S&P500 returns using a time varying autocorrelation test and find evidence of the AMH, with the US market most inefficient during the late 1980s and becoming most efficient around 2000. Kim et al. (2011) implement an automatic variance ratio test and automatic portmanteau test to examine stock return predictability of daily DJIA data over time. They use a rolling window and find strong evidence of time-varying predictability which is driven by market conditions. Further, Lim et al. (2013) show that the three largest US indices have time-varying properties using a rolling window AR and WBAVR test. They argue that markets must go through periods of efficiency and inefficiency.

Urquhart and Hudson (2013) implement linear and nonlinear techniques to investigate the AMH in the US, the UK and Japanese stock markets using very long run historical data. They show that the AMH provides a better description of the behaviour of stock returns than the EMH with each of the three markets going through periods of independence and dependence. Zhou and Lee (2013) apply the automatic variance ratio test and the automatic portmanteau test to REIT data and show that market efficiency varies over time depending on market conditions. Hull and McGroarty (2014) examine 22 emerging markets over 16 years data using the Hurst–Mandelbrot–Wallis rescaled range as a measure of market efficiency and they find strong evidence consistent with the AMH. Ghazani and Araghi (2014) study the AMH on daily data of the Tehran stock exchange from 1999 to 2013 and conclude that the AMH gives an appropriate evolutional perspective on market efficiency. Manahov and Hudson (2014) develop artificial stock markets using a special adaptive form of the Strongly Typed Genetic Programming based learning algorithm and apply it to data from the FTSE100, S&P500 and Russell 3000. Their result shows that the stock market dynamics are consistent with the evolutionary process of the AMH since trader population behave in an efficient adaptive system evolving over time.

Thus, the recent empirical studies find strong evidence consistent with the AMH which is consistent with Soufian, Forbes, and Hudson (forthcoming), who propose three testable hypotheses to establish the degree to which observable trading behaviour is consistent with the principles of bounded rationality. They argue that the AMH gives a theoretical basis for a new financial paradigm which better describes the financial crises.

3.4 Return and volatility

Returns and volatility in terms of trading price and NAV

The returns and volatilities of international ETFs are calculated in terms of their trading prices or their NAV. Previous studies (e.g. Rompotis, 2015; Tse & Martinez, 2007) compare returns and return volatilities estimated using trading prices and NAV. Rompotis (2015) reports that the mean NAV return is higher than the closing price return whereas the closing price return variance is found to be higher than the NAV return variance. Moreover, Tse and Martinez (2007) perform return variance analyses and reports that the closing price return variance is higher than the NAV return variance. Tse and Matinez further argue that the higher differences between price return variance and the NAV return variance indicate the existence of more *noise trading* of international ETFs.

Similar comparison of return and volatility estimated in trading price and NAV is also studied by some researchers based on closed-end funds, such as Pontiff (1997) who studies volatility of closed-end fund by comparing the price return volatility with the NAV return volatility, concluding that monthly fund price returns present, on average, a higher volatility than do the funds' respective NAVs. The author attributes the higher price variance to noise trading. Likewise, Klibanoff, Lamont, and Wizman (1988) study price returns and NAV returns of 39 single country closed-end funds that are listed and traded in U.S. markets. They conclude that price returns are not efficient, since they incorporate, on average, only about 60% of NAV return information.

Intraday and overnight return volatility

For a more precise understanding of the return and volatility behaviour of international ETFs, many previous studies (Gutierrez, Martinez, & Tse, 2009; Kang & Babbs, 2012; Tse & Martinez, 2007) separately measure and compare the intraday and overnight returns and volatilities of international ETFs. Some studies find that the overnight mean returns are greater than the intraday mean returns; while some find contrary results that mean returns during the trading hours are greater compare to the non-trading hours. According to Tse and Martinez (2007), the intraday and overnight mean return variances of international ETFs are 62% and 77%, respectively. In another study by Gutierrez et al. (2009) the overnight return volatility is also found to be higher than the intraday return volatility for the case of ETFs tracking Asian indices; the authors attributed their findings to the release of public information during the trading session of the underlying markets. In addition, Kang and Babbs (2012) examine fifteen equity ETFs and find that overnight returns on the funds have higher means, lower variances, and distributions with fatter tails than intraday returns.

3.5 Tracking ability

Definition and measurement of tracking error

Tracking ability is another important performance metric of the international ETFs. It is the ability of international ETFs to replicate the performance of their foreign tracking indices. There are five different ways in the literature to compute the tracking error (Aroskar and Ogden, 2012).

The first and most simple way to compute the tracking error is simply taking the difference between the return of the benchmark index and the return of the ETF (Wong & Shum, 2010). Because the error can be positive or negative, this method may underestimate the error because of the cancelling out issue of the positive and negative values. The second method uses the mean absolute tracking error which is computed by taking the absolute value of the simple difference in returns, summing these and taking the average of the sum (Frino & Gallagher, 2002; Frino, Gallagher, & Oetomo, 2005). A third method is the standard deviation of the return difference (Frino & Gallagher, 2001). A fourth measure is to use the R-squared and the beta of a simple linear regression of the return of the ETF on the return of the benchmark (Chu, 2011). The fifth way to measure the tracking error is by looking at the standard error of the regression mentioned in the previous method (Rompotis, 2005).

Tracking error in Index Funds

Gruber (1996) is the first study conducted on the performance of index funds by using the Jensen alpha and documents that a sample of the US S&P 500 index funds underperforms the benchmark index by approximately 0.202% per annum on an after-cost basis during the period 1990 to 1994.

Frino and Gallagher (2001) highlight the reasons why tracking error is inherent in index fund performance. They evaluated the magnitude of S&P 500 index fund tracking error and compared the performance of active funds relative to index funds. They point out tracking error will always exist due to expenses, dividend payments, and the size and timing of index rebalancing. Gallagher (2002) extend their previous research to a sample of Australian index funds and documents a substantial higher tracking error ranging from 0.074% to 0.224% per month.

Cresson et al. (2002) examines the tracking performance of a set of daily returns of S&P 500 index funds by applying a naive measure of tracking performance – fund R^2; it documents that the tracking performance measures based on the daily returns are substantially below the previous research that are based on monthly returns and a regression of transformed R^2 for each index fund on the determinants indicate the R^2 values are positively related to fund size and fund manager tenure.

Tracking error in domestic ETFs

Gallagher and Segara (2005) investigate the tracking errors of ETFs on the Australian stock exchange and compare the tracking error volatility between ETFs and equity index funds operated off-market. They argue that ETFs are better to track their benchmarks than off-market index funds, and conclude that investors with a long-term horizon will still be able to earn returns similar to the index returns.

Milonas and Rompotis (2006) reveal that Swiss ETFs are subject to both lower returns and higher risk, as measured by the standard deviation of daily returns, than their benchmark indexes. The reason for the lower returns is among other things that the ETFs deviate from a perfect replication as indicated by their modest beta values. The authors also uncovered a negative relationship between expenses and performance.

Chu (2011) works on daily basis ETFs in the Hong Kong stock market and find high tracking error in the market as compared to the stock markets of the US and Australia. Rompotis (2011a) compares ETFs and mutual funds in Greek market and find that the traditional mutual funds are more expensive, less volatile and show better performance.

A study conducted by Rompotis (2012b) on the performance of 43 German ETF reveal that the benchmark indexes clearly outperform the ETFs. This situation is due to insufficient replication on behalf of the ETFs. In addition, factors such as the bid-ask spread, risk, and premium/discounts reflected in the prices of ETFs contribute to the size of the tracking error. In contrast, the expense ratio fails to show any statistically significant relationship to tracking error which in a way goes against common beliefs and expectations.

Buetow and Henderson (2012) analyse ETFs that trade on the US markets and find that the majority of ETFs track their benchmark closely but there are some ETFs with significant error. This is true for ETFs that tried to track an index comprising of less liquid assets struggled to replicate the index's return. The tracking error is estimated using the average tracking error and the absolute tracking error. The average tracking error shows very hopeful results with an average tracking error of zero but the absolute tracking error is about 0,38%.

Tracking error in commodity ETFs

Saleem and Khan (2013) conduct a research on Gold ETFs traded in India and find them less volatile, easily diversified with minimum tax implications and low risk. Bas and Sarioglu (2015) use daily data of most ETFs traded on the Turkish capital markets. The authors' result shows the Turkish ETFs underperform their underlying indices. They adopted three different methods to measure the tracking errors which they find significantly different from zero. Going further, they establish that the tracking errors of Turkish ETFs are higher compared to the ETFs traded in developed countries.

Tracking error in International ETFs

Pennathur et al. (2002), Miffre (2007) and Kanuri and McLeod (2015) question the diversification benefits of international ETFs due to the presence and persistence of tracking error over time. Blitz and Huij (2012) compare the tracking efficiency of international ETFs tracking of developed and developing market indices and report that the tracking errors of international ETFs with developing markets' benchmark indices are greater than the tracking errors indices of developed markets. However, Svetina (2010) notes a higher tracking error of international ETFs compare to the domestic ETFs, suggesting transaction cost as the possible reason. Moreover, Shin and Soydemir (2010) find that ETFs tracking foreign indices are exposed directly to the exchange rate risk unlike those that track the U.S. indices. This is why the tracking error of international ETFs is relatively higher than that of domestic ETFs. However, Johnson (2009) studied tracking error between foreign ETFs and the underlying home index and foreign index returns relative to the U.S. index and whether the foreign exchange trades simultaneous with the U.S. markets were significant explanatory variables.

A number of studies (Blitz & Huij, 2012; Shin & Soydemir, 2010; Svetina, 2010) report tracking error of international ETFs. Johnson (2009) conducts a study on 20 foreign country stock exchanges and finds that as the number of overlapping hours with the US stock exchange increases, there is an increase in the correlation between the ETF and its underlying index which ultimately reduces the tracking error. Shin and Soydemir (2010) estimate the tracking errors of 26 ETFs based on three different methods. They find that the tracking errors are significantly different from zero, and their persistence is displayed by the results of a serial correlation test and run test. A larger persistence level is found among Asian ETFs, which reveals that Asian markets are less efficient in disseminating information.

Svetina & Wahal (2008) used a sample of 584 ETFs to demonstrate that on average ETFs underperform their underlying benchmark, due to transaction costs. Domestic equity ETFs representing approximately 60% of the sample underperform their benchmark by 0.26 percent per year, while international equity ETFs underperform by 0.19 percent per year.

Tracking performance after risk-adjustment

In addition, some studies (Rompotis, 2010b, 2015) employ several asset pricing models to evaluate the performance of international ETFs by controlling the risk factors such as size, value, and momentum, the results are mixed and fund-specific. The findings of Rompotis (2010b) and Rompotis (2015) provide some useful insights on the investment strategies (such as active or passive) and replication strategies (such as full, optimized or synthetic) of the international ETFs.

3.6 Pricing inefficiency

Definition and measurement of pricing efficiency

Charupat and Miu (2011) describe pricing efficiency as the relationship between an ETF's prices and its respective net asset. In the view of ETFs, (Aber, Li, & Can, 2009; Charupat & Miu, 2011; Engle & Sarkar, 2006; Jares & Lavin, 2004; Kayali & Ozkan, 2012; Lin & Chou, 2006) analyze the relative price differences between the price and its NAV in the so-called Premium/Discount (PD) Analysis.
Other studies by Kostovetsky (2003), Gallagher and Segara (2006), Rompotis (2008), Shin and Soydemir (2010), and Tzvetkova (2005) use quadratic and linear price deviation measures.

Various studies (Ackert & Tian, 2000; Bas & Sarioglu, 2015; Charupat & Miu, 2013b; Dorfleitner, Gerl, & Gerer, 2017; Elton, Tripathi & Garg, 2016) have studied the price behaviour of ETFs. Some use daily while other use intraday data and primarily observe whether the price of ETF deviate from NAV. Many of these studies also investigated the persistence of arbitrage opportunity.

Pricing inefficiency in domestic ETFs

Prusevic (2012) argues that pricing efficiency in financial markets is the concept mostly relevant in relation to ETFs only, according to him it is meaningless to discuss pricing efficiency of stocks or mutual funds. The author justified his argument explaining that the objective fundamental valuation of stocks is not accessible to the public, which is the case in the context of ETFs, whereby the fundamental value is reflected in its NAV; and in case of mutual fund all trades take place at their NAV prices.

Premiums/discounts are normally small and do not prolong particularly for domestic ETFs. Ackert and Tian (2000) examine the pricing efficiency of Spider ETF, they find that even though there is significant variation in the price deviation of Spider ETF over the period of time but this deviation in price is economically irrelevant and they conclude that ETF is moderately price efficient. The result is subsequently confirmed by Elton et al. (2002), who find that the pricing inefficiency of the Spider ETF vanishes within a day and suggest that the price of Spider ETF is in line with its NAV.

Curcio, Lipka, and Thornton Jr (2004) compare price deviations of two ETFs (1) the SPDR and (2) the Nasdaq 100 Index Tracking Stock (QQQ); they find that the average price deviations are very small for both ETFs, but the range and standard deviation of QQQ price deviations are greater than that of SPDR. Gallagher and Segara (2006) examine the trading characteristics of Australian ETFs. They document small dollar and percentage differences in price and NAV that does not persist over time. Jares and Lavin (2004) provide empirical evidence that the prices of Japan and Hong Kong iShares deviate from the values of underlying indices. They find -0.34% and -0.21% discounts, on average, for Japan and Hong Kong iShares over the time period they analyzed. Lin and Chiang (2005) find that the Taiwanese domestic ETF market traded at statistically significant deviations from their NAV, but these deviations disappeared within two days of trading which also suggests that the Taiwanese ETF market is relatively efficient.

Engle and Sarkar (2006) study 21 ETFs on the US domestic indices, such as S&P 500, Nasdaq 100, the Dow Jones Industrial Average and Russell 1000, and sectoral indices. They report that price deviations are on average very small and within the transaction costs and bid-ask spreads. Their results also show that the volatility of price deviations is related to the volatility of the underlying NAVs, which is consistent with the findings of Curcio et al. (2004) that price deviations of QQQ are more volatile than those of SPDR (the Nasdaq 100 index is more volatile than the S&P 500 index).

Rompotis (2006) examines the pricing efficiency of a sample of 30 American ETFs by regressing trading values of ETFs and its NAVs. The author finds that a majority of sample's ETFs trade in premium and only a few trade in discount. However, the average premium/discount does not exceed 10 basis points, a fact which indicates efficient execution of arbitrage strategies by institutional investors.

Kayali (2007) investigates the pricing efficiency of Dow Jones Istanbul 20 (DJIST), the first ETF in Turkey. The author documents a statistically significant but small discount on average, which, considering the transaction costs associated with arbitrage, seem to be economically insignificant. Further, the author’s results show that the premium/discount does not persist over time and disappear within two days.

Rompotis (2010b) examines the deviations between price and NAV of ETFs using a sample of 50 Barclay's iShares for the period 2001-2007. The author's results indicate that on average, ETFs trade at a slight daily premium to their NAV in both dollar and percentage terms, amounting to $0.018 and 0.059%, respectively, which does not persist due to effective arbitrage mechanism and disappears within two successive trading days. Jiang et al. (2010) find that the SSE 50 ETF is traded at a small premium of just 0.023 percent on average, which is not statistically significant. Furthermore, the deviations does not persist over time and disappeared within three trading days. Hence, they conclude that the SSE 50 ETF is pricing-efficient.

DeFusco, Ivanov, and Karels (2011) show that the creation/redemption of ETF units, and the lack of a direct way to trade an index left a predictable and nonzero pricing deviation which is an additional cost of administering the ETF. They specified the price deviation in actual dollar terms, the Spider's price is 29 cents higher on average than the S&P500 index price, the Diamonds' price is 8 cents higher on average than the price of the DJIA, and Cubes have a price below the index price (an average of 25 cents).

Garg and Singh (2013) examine the pricing efficiency of ETFs in India by analyzing a sample of 12 ETFs listed on the National Stock Exchange of India over the period of 2002 to 2009. The study shows evidence of significant pricing deviations for all the ETFs under study which also persisted over a number of days for most ETFs. The study pointed out gross pricing inefficiencies and unexploited arbitrage opportunities in the Indian ETF market.

Charteris (2013) examines the pricing efficiency of domestic ETFs in South Africa and find that six of the seven funds examine traded at a significant premium/discount to their NAV, although most of these deviations does not persist for more than two days, which suggests that the South African ETF market is price efficient. Petajisto (2013) finds that the prices of ETFs can differ significantly from their NAV. In theory the creation/redemption mechanism should operate in an efficient way and prevent this mispricing through arbitrage. However, it seems that differences can occur and on average they fluctuate within a band of 260 basis points. More specifically Petajisto (2013) reports that, on average, premium of price over NAV is 14 basis points, implying that the ETFs are not significantly overpriced nor underpriced.

Swathy (2015) discovers that equity ETFs listed on the NSE traded at their NAVs and there are no opportunity for arbitrageurs in the market. Purohit and Malhotra (2015) observe in the case of Indian ETFs the average persistence in premium/discount is for three days and the findings are consistent with Shanmugham and Zabiulla (2012) but for some ETFs the price deviation persisted for four to five days. Bas and Sarioglu (2015) examine pricing efficiencies of 16 ETFs operating in Turkish Capital Market for the period 2005-2013. They employed four different pricing efficiency calculation methods and concluded that ETFs are priced efficiently and thus no arbitrage opportunity exists in the market which confirmed that the process of ETFs creation/redemption functioned effectively.

Pricing inefficiency in international ETFs

Engle and Sarkar (2006) emphasize the importance of another important performance metric i.e. pricing efficiency of the international ETFs. They argue that the pricing inefficiencies in international ETFs are relatively more persistent and difficult to eliminate through the creation/redemption process. Several previous studies (Ackert & Tian, 2008; Delcoure & Zhong, 2007; Levy & Lieberman, 2013) endorse that the deviations of the trading price of international ETFs from their NAVs are more material, frequent and persistent compared to other ETF types. Engle and Sarkar (2006) compare the pricing efficiency of 21 domestic and 16 international ETFs on a daily and intra-day basis. They find that domestic ETFs have very small premiums that last for few minutes while international ETFs have larger and more persistent premiums that last for three hours or longer to adjust. The findings of Ackert and Tian (2008) are also consistent with the findings of Engle and Sarkar (2006). Ackert and Tian (2008) examine the pricing efficiency of 7 domestic and 21 international ETFs and conclude that international ETFs trade at a larger premium compared to the domestic ETFs. However, Delcoure and Zhong (2007) exclusively sample 20 international ETFs and find that these ETFs trade at significant premiums which usually persist for one or two days. In addition, Levy and Lieberman (2013) study 17 US-listed international ETFs and find that the prices of these ETFs are mainly driven by their NAVs during the synchronized trading hours while during the asynchronous trading hours, the S&P 500 Index has the dominant effect on the pricing of international ETFs.

Charupat and Miu (2013b) suggest that price deviations of international ETFs / country ETFs are larger and more volatile. According to the authors, this is because the NAVs use in the calculations are based on prices from earlier closing times than the US market closes. Although the NAVs have been adjusted at the prevailing exchange rates, other market information do not fully include in the price due to the non-synchronous trading hours. In addition, the arbitrage mechanism is also ineffective because of different trading hours between the US and other countries market.

Several studies show that international ETFs are not so price efficient when compare with other type of ETFs. (Ackert & Tian, 2008; Jares & Lavin, 2004; Levy & Lieberman, 2013; Shum, 2010; Tse & Martinez, 2007)

Engle and Sarkar (2002) examine the premiums and discounts of both domestic and international ETFs. They report smaller premiums and discounts for the domestic ETFs compared to international ETFs. This evidence suggests that domestic ETFs are priced more efficiently than international ETFs.

Hughen (2003) investigates the impact of the changes in arbitrage mechanism on the premiums and discounts of the iShares Malaysia Fund. This international ETF has larger premiums and discounts over the period that arbitrage is suspended. The author's result shows how critical the arbitrage mechanism is for the pricing of ETFs.

Prusevic (2012) extensively studies the pricing efficiency of 115 US listed ETFs of different categories which includes 80 ETFs with the exposure of domestic indices and 35 ETFs with the exposure of international indices. Prusevic employs descriptive statistical techniques to compare the pricing efficiency of domestic and international ETFs and find that the group of international ETFs exhibit significantly worse pricing efficiency than the group of domestic ETFs which consists of ETFs with different exposures such as the broad US, stylized, thematic, sectoral, actively-managed, fixed income, leveraged and inverse. Further to study the factors affecting the pricing efficiency of domestic and international ETFs, Prusevic employs fixed-effect panel data analysis and find that creation/redemption process, trading intensity and price volatility have no significant effect on the pricing efficiency of domestic ETF, but on the contrary creation/redemption process, trading intensity and price volatility reveals to be significantly related to the pricing error of international ETFs.

Engle and Sarkar (2006) examine 16 ETFs on international indices from their inception date (which is different for each of the 16 ETFs) to September 2000, and report that their average price deviations are much larger than the average for domestic ETFs (0.35 percent vs 0.01 percent). The volatility of their price deviations is also larger. More importantly, Engle and Sarkar (2006) show that international ETFs have price deviations that are more persistent than those of domestic ETFs (several days versus several minutes).

Using data from a slightly longer period starting from the inception date of each ETF up to October, 2002, Delcoure and Zhong (2007) calculates the price deviations of 20 iShares ETFs, each of which tracks an MSCI country-specific index. In their calculations, the authors attempt to remedy the non-synchronous NAV problem by adjusting the NAVs using the methods proposed by Goetzmann, Ivković, and Rouwenhorst (2001) and Engle and Sarkar (2006). They too reported that iShares generally trade at economically significant premiums between 10 and 50 percent of the time. The premiums, however, are not persistent and disappear within two days.

Using data from a later period (i.e. 2002-2005), Ackert and Tian (2008) compare 21 international ETFs to seven domestic ETFs and obtain qualitatively similar results. They also find that, among the 21 international ETFs, those that track emerging-market indices have larger median price deviations with greater volatility than those that track developed-market indices. Moreover, Ackert and Tian (2008) report statistically significant first-order autocorrelations of price deviations (an average of 0.20 for developed-market ETFs and 0.41 for emerging-market ETFs). They argue that non-synchronous trading hours can only explain part of the autocorrelations as some ETFs with large autocorrelations are those that track indices in countries in the same time zone as the US.

Madura and Richie (2004) report that, compared to broad-based ETFs, international ETFs are much more prone to extreme price movements, a significant portion of which is reversed in the subsequent trading session (e.g. if an extreme return occurs during normal trading hours, part of it is reversed during after-hour trading). The results of Madura and Richie (2004) suggest the existence of overreaction, which then leads to return predictability in a subsequent period.

On the other hand, Tse and Martinez (2007) compare the volatility of daytime returns to the volatility of overnight returns of 24 international iShares ETFs. They find that the overnight variances are larger than the daytime variances for the iShares that track Asian and European markets, while the opposite is true for iShares that track American markets (i.e. Canada, Mexico and Brazil). They conclude that, because the Asian markets (and to a lesser extent, the European markets) have non-overlapping trading hours with the US markets while the American markets share the majority of trading hours with the US markets, their results suggest that volatility is driven by the release of public information in the foreign markets, rather than by noise trading activity or private information during the US market trading hours. Tse and Martinez (2007) also demonstrate that the pricing of international ETFs is efficient, as their prices reflect fundamental information from the underlying indices.

Petajisto (2013) finds that the funds with liquid domestic securities are relatively price efficient, whereas the funds holding international or illiquid securities exhibited significant premiums relative to NAVs. Marshall, Nguyen, and Visaltanachoti (2013) investigate the intraday mispricing between SPDR Trust (ticker SPY) and iShares (ticker IVV) using pairs trading strategy in a high frequency environment (15 seconds trading interval). They find that the price deviations returned back to parity following mispricing with a median duration of approx. 1–2 minute. The results provide evidence that arbitrageurs do act to profit from the mispricing and their actions lead to short-lived mispricing, which can only be detected using high frequency trading intervals.

Levy and Lieberman (2013) also casts doubt on the pricing efficiency of international ETFs. Using intraday data, Levy and Lieberman (2013) examine the pricing of 17 international ETFs (nine Asian and eight European) during overlapping trading hours versus non-overlapping trading hours (in a given day in the US market). Their goal is to find out whether there is a difference in the price formation process of these ETFs between the two periods. They report that during the overlapping hours, the NAV returns (i.e. the returns in the foreign markets), rather than the US market returns (as proxied by the S&P 500 index returns), have the biggest influence on the ETF returns. However, when the foreign markets are closed, the US market returns account for a large part of the ETF returns. Their finding is consistent with the hypothesis that during the non-overlapping trading hours, traders overreact to the US market sentiment.

Pricing inefficiency in leveraged ETFs

Finally, we discuss the pricing efficiency of leveraged ETFs, which are a new but very popular type of ETFs. The goal of these leveraged ETFs is to generate daily returns that are in a positive or a negative multiple of the daily returns on an underlying index. Currently, the available multiples are +2x, +3x,-1x, -2x and -3x. In order to generate the promised returns, the funds use leverage, which is typically obtained through derivatives such as futures contracts, forward contracts and total-return swaps. As a result, these funds generally do not hold the constituent stocks of the underlying indices. This has an implication on their creation/redemption process (and thus the arbitrage activity) because they have to use an in-cash process rather than an in-kind process.

Charupat and Miu (2013a) measure premiums/discounts of 18 leveraged ETFs based on the S&P 500, Nasdaq 100 and Russell 2000 indices. They find that the price deviations, on average, are small and within the range of transaction costs and bid-ask spreads. In addition, they report that the price deviations follow particular patterns. For example, bull funds (i.e. those with positive multiples) trade at a discount more often than bear funds (i.e. those with negative multiples). Also, price deviations of bull (bear) funds are negatively (positively) correlated with the returns on their own underlying index. Charupat and Miu (2013a) attribute this behaviour partly to the funds' daily exposure adjustments, which have to be done at the end of each trading day in order to maintain their leverage ratios.

3.7 Conclusion

This chapter reviews some important literature on random walk, calendar anomalies, return and volatility measured in trading price and NAV, intraday and overnight return volatility, tracking ability and pricing inefficiency. The literature on the efficiency and performance metrics are mainly concentrated on stocks and indices. On the other hand, a few studies focuses on traditional ETFs whereas the efficiency and performance of international ETFs are still under-research. This study is therefore an endeavour to fill this gap in the literature by investigating various aspects of informational efficiency and performance of international ETFs.

Chapter 4
Data and methodology

4.1 Introduction

Chapter 4 explains the study sample and methodology to answer each research objective. Section 4.2, 4.3 and 4.4 discuss the methods used to examine the random behaviour, calendar anomalies and performance dynamics of international ETF, respectively. Section 4.5 summarizes and concludes the chapter.

4.2 Sample selection and data collection

The study sample comprises of 56 US-listed international ETFs offering Asia-Pacific and European market exposures to the investors. The selected sample is based on two criteria (1) geographic focus of the international ETFs must be Asia Pacific and European markets, as the study compares the market efficiency and performance of international ETFs based on the underlying region of the benchmarks, (2) asset class focus of the international ETFs should be equity, as different asset classes has different dynamics. Thus, we limit the scope of this study by selecting only those international ETFs which tracks the performance of equity-based tracking indices. Daily historical data of sample ETFs is downloaded from Bloomberg database for the 10 years' time span, from 3 January 2007 to 30 December 2016. We uses R-programming, an open-source statistical tool, for data wrangling and analyses.

Table 4-1 describes the profile of ETFs of the study. The information given in the table includes the Bloomberg tickers of ETFs, their names and the names of their benchmark indices. It also shows the inception date, expense ratio, average daily trading volume, totals assets of each ETF, as of 3 October 2017. Based on the underlying markets, we classify full sample into Panels A and B. Panel A is for ETFs offering exposure of Asia-Pacific while Panel B is for ETFs investing in European markets. Each of the two panels comprises of 28 ETFs. The average intraday volatility is calculated as the difference between the highest and lowest trading price divided by the closing price on a particular day. Trading frequency is calculated as the trading days with non-zero volume divided by the total number of trading days for each ETFs.

Table 4-1: Profiles of International ETFs tracking Asia-Pacific and European Indices

Table 4-1 is divided into two panels A and B, each panel has 28 ETFs with their profile related information including Bloomberg ticker for ETFs and their benchmark indices; name and inception date of ETFs; their expense ratio, trading volume, assets, intraday volatility and trading frequency of each ETFs.

Panel A: Profiles of international ETFs tracking Asia-Pacific Indices

S#	Ticker	Name	Benchmark	Inception Date	Expense Ratio	Volume	Assets	Intraday Volatility	Trading frequency
1	AAXJ	iShares MSCI All Country Asia ex Japan ETF	NDUECAXJ Index	13/08/2008	0.72	621,171	4,204,400,916	1.61%	93.12%
2	AIA	iShares Asia 50 ETF	SPAS50NT Index	13/11/2007	0.50	32,803	468,681,113	1.49%	91.19%
3	AXJV	iShares Edge MSCI Min Vol Asia ex Japan ETF	M1APJVO Index	3/06/2014	0.35	5,270	6,982,865	0.19%	86.11%
4	DVYA	iShares Asia/Pacific Dividend ETF	DJAPSDT Index	23/02/2012	0.49	11,187	41,268,658	0.65%	96.98%
5	ECNS	iShares MSCI China Small-Cap ETF	MSLUCHNN Index	28/09/2010	0.64	10,028	23,007,626	1.31%	89.46%
6	EEMA	iShares MSCI Emerging Markets Asia ETF	NDUEEGFA Index	8/02/2012	0.49	29,020	507,817,486	0.86%	97.78%
7	EIDO	iShares MSCI Indonesia ETF	MIMUINON Index	5/05/2010	0.63	478,651	489,193,848	1.56%	95.12%
8	ENZL	iShares MSCI New Zealand Capped ETF	M1CXBLRK Index	1/09/2010	0.48	45,082	172,199,717	1.07%	90.48%
9	EPHE	iShares MSCI Philippines ETF	MIMUPHIN Index	28/09/2010	0.64	215,159	175,456,225	1.23%	89.40%
10	EPP	iShares MSCI Pacific ex Japan ETF	NDDUPFXJ Index	25/10/2001	0.49	899,051	3,092,809,942	1.45%	99.92%
11	EWA	iShares MSCI Australia ETF	NDDUAS Index	12/03/1996	0.48	2,889,905	1,733,576,223	1.59%	99.96%
12	EWH	iShares MSCI Hong Kong ETF	NDDUHK Index	12/03/1996	0.48	4,673,897	1,848,097,337	1.42%	99.92%
13	EWJ	iShares MSCI Japan ETF	NDDUJN Index	12/03/1996	0.48	7,268,228	15,998,310,005	1.14%	99.92%
14	EWM	iShares MSCI Malaysia ETF	NDDUMAF Index	12/03/1996	0.48	521,496	439,561,297	1.41%	99.92%
15	EWS	iShares MSCI Singapore Capped ETF	M1CXBLY Index	12/03/1996	0.48	1,221,571	575,266,118	1.38%	99.92%
16	EWT	iShares MSCI Taiwan Capped ETF	M1CXBLZ Index	20/06/2000	0.64	4,719,238	3,652,582,226	1.45%	99.96%
17	EWY	iShares MSCI South Korea Capped ETF	M1CXKR5I Index	9/05/2000	0.64	2,909,692	3,739,590,053	1.53%	99.92%
18	FXI	iShares China Large-Cap ETF	TXIN0UNU Index	5/10/2004	0.74	21,230,847	3,434,027,411	1.83%	99.96%
19	HEWJ	iShares Currency Hedged MSCI Japan ETF	M0JPHUSD Index	31/01/2014	1.02	559,512	1,248,128,836	0.89%	97.35%
20	INDA	iShares MSCI India ETF	NDEUSIA Index	2/02/2012	0.71	991,824	4,969,106,604	1.03%	98.17%
21	INDY	iShares India 50 ETF	BXTRNIF$ Index	18/11/2009	0.93	165,657	1,114,897,457	1.12%	88.89%
22	IPAC	iShares Core MSCI Pacific ETF	M1PCIME Index	10/06/2014	0.10	71,536	1,131,429,121	0.76%	85.58%
23	JPMV	iShares Edge MSCI Min Vol Japan ETF	M1JPMVOE Index	3/06/2014	0.30	7,248	32,071,990	0.36%	86.11%
24	JPXN	iShares JPX-Nikkei 400 ETF	JPNKNTR Index	23/10/2001	0.48	23,246	90,492,360	1.00%	99.92%
25	MCHI	iShares MSCI China ETF	NDEUCHF Index	29/03/2011	0.64	585,249	2,531,987,300	1.09%	95.90%
26	SCJ	iShares MSCI Japan Small-Cap ETF	NCUAJN Index	20/12/2007	0.48	19,299	199,583,535	0.97%	90.20%
27	SMIN	iShares MSCI India Small-Cap ETF	MSLUINDN Index	8/02/2012	0.80	14,031	210,863,316	1.37%	97.78%
28	THD	iShares MSCI Thailand Capped ETF	M1CXTH5I Index	26/03/2008	0.63	208,539	381,076,869	1.54%	97.44%

Panel B: International ETFs tracking European Indices									
S#	**Ticker**	**Name**	**Benchmark**	**Inception Date**	**Expense Ratio**	**Volume**	**Assets**	**Intraday Volatility**	**Trading frequency**
29	EDEN	iShares MSCI Denmark Capped ETF	M1DK5IM Index	25/01/2012	0.53	21,667	67,454,790	0.78%	98.73%
30	EFNL	iShares MSCI Finland Capped ETF	M1FI5IM Index	25/01/2012	0.53	12,290	46,299,454	0.76%	98.65%
31	EIRL	iShares MSCI Ireland Capped ETF	M1CXIEAC Index	5/05/2010	0.48	29,498	71,790,441	1.24%	95.24%
32	EIS	iShares MSCI Israel Capped ETF	MISCNU Index	26/03/2008	0.64	48,263	92,458,364	1.38%	97.40%
33	ENOR	iShares MSCI Norway Capped ETF	M1NO5IM Index	23/01/2012	0.53	16,388	33,714,329	0.93%	98.81%
34	EPOL	iShares MSCI Poland Capped ETF	M1CXPL5I Index	25/05/2010	0.64	186,410	356,139,805	1.45%	94.39%
35	ERUS	iShares MSCI Russia Capped ETF	MSEURU$N Index	9/11/2010	0.64	169,008	612,767,266	1.70%	87.81%
36	EUFN	iShares MSCI Europe Financials ETF	NDRUFNCL Index	20/01/2010	0.48	175,247	1,905,790,798	1.33%	99.26%
37	EUMV	iShares Edge MSCI Min Vol Europe ETF	M00IER$O Index	3/06/2014	0.25	16,448	35,392,866	0.51%	86.11%
38	EWD	iShares MSCI Sweden Capped ETF	M1CXBLV Index	12/03/1996	0.48	257,130	479,030,207	1.68%	99.92%
39	EWG	iShares MSCI Germany ETF	NDDUGR Index	12/03/1996	0.48	3,339,165	4,705,640,819	1.54%	99.92%
40	EWGS	iShares MSCI Germany Small-Cap ETF	NCUDGR Index	25/01/2012	0.59	7,727	51,310,779	0.72%	98.73%
41	EWI	iShares MSCI Italy Capped ETF	M1CXBLRM Index	12/03/1996	0.48	569,897	887,541,157	1.69%	99.92%
42	EWK	iShares MSCI Belgium Capped ETF	M1CXBLRJ Index	12/03/1996	0.48	173,845	67,755,695	1.37%	99.92%
43	EWL	iShares MSCI Switzerland Capped ETF	M1CXBLRO Index	12/03/1996	0.48	399,918	1,243,064,689	1.23%	99.96%
44	EWN	iShares MSCI Netherlands ETF	M1CXNIC Index	12/03/1996	0.48	160,552	202,399,765	1.36%	99.96%
45	EWO	iShares MSCI Austria Capped ETF	M1CXBLRQ Index	12/03/1996	0.48	151,219	240,539,136	1.55%	99.96%
46	EWP	iShares MSCI Spain Capped ETF	M1CXBLRP Index	12/03/1996	0.48	662,447	1,534,713,122	1.66%	99.92%
47	EWQ	iShares MSCI France ETF	NDDUFR Index	12/03/1996	0.48	529,990	636,626,394	1.51%	99.96%
48	EWU	iShares MSCI United Kingdom ETF	NDDUUK Index	12/03/1996	0.48	1,009,349	2,656,216,756	1.43%	99.92%
49	EWUS	iShares MSCI United Kingdom Small-Cap ETF	NCUDUK Index	25/01/2012	0.59	7,553	35,632,245	0.69%	98.65%
50	EZU	iShares MSCI Eurozone ETF	NDDUEMU Index	25/07/2000	0.48	2,529,517	13,931,762,827	1.49%	99.96%
51	HEWG	iShares Currency Hedged MSCI Germany ETF	M0DEHUSD Index	31/01/2014	1.01	699,196	685,330,286	1.00%	97.35%
52	HEZU	iShares Currency Hedged MSCI Eurozone ETF	M0EMHUSR Index	9/07/2014	1.10	941,674	1,881,111,305	0.99%	82.94%
53	IEUR	iShares Core MSCI Europe ETF	MIMUEURN Index	10/06/2014	0.10	120,351	3,208,069,017	0.96%	85.58%
54	IEUS	iShares MSCI Europe Small-Cap ETF	M1EUSC Index	12/11/2007	0.40	7,369	173,865,041	1.29%	91.31%
55	IEV	iShares Europe ETF	SPE35CUN Index	25/07/2000	0.60	630,513	3,213,215,541	1.37%	99.92%
56	TUR	iShares MSCI Turkey ETF	MIMUTURN Index	26/03/2008	0.64	289,726	375,926,396	2.14%	97.44%

4.3 Random Walk Hypothesis

Several studies used serial correlation and variance ratio (VR) tests, while Wald and Wolfowitz (1940) *runs test* and *BDS test* to examine the patterns in security returns. According to Hiremath (2014), the conventional tool such as autocorrelation suffer from the restrictive assumptions and hence tends to be less efficient tool to measure the random behaviour of security returns. A new class of VR tests has gained remarkable popularity over the years for examining RWH. Previous studies (Cochrane, 1988; Lo & MacKinlay, 1988; Poterba & Summers, 1988) use VR tests to examine if the given time series is a set of independently and identically distributed (iid) observations. There are two popular VR tests; one is Lo and MacKinlay (1988) test which is an individual VR test while the other is Chow and Denning (1993) multiple VR test. Lo and MacKinlay test determines whether variance ratio of each holding period separately equals to one albeit RWH requires variance ratios to be jointly equal to one for all holding periods. On the other hand, Chow and Denning test is more useful to determine if the variance ratios are jointly equal to one for all holding periods.

4.3.1 Lo and MacKinlay (1988) individual variance test

The VR test is often used to investigate the return generation process of return series whether it follows a random walk or not. The key to VR test is the linearity of random walk increment in each period. The $V(q)$ is the ratio between $(1/q)^{th}$ variance of the $q-period$ returns to the variance of the one-period return. Hence, for RWH hold true, it requires $V(q) = 1$.

$$V(q) = \frac{Var(x_t + x_{t-1} + \cdots + x_{t-q+1})/q}{Var(x_t)} = 1 \tag{4-1}$$

Campbell et al. (1997a) further elaborate and put $q = 2$ the variance ratio $V(2)$ is then defined as the ratio between $Var[r_t(2)]$ to $2Var[r_t]$; whereas $r_t(2) \equiv r_t + r_{t-1}$, is the variance of returns at $q = 2$. Mathematically, the variance ratio $VR(2)$ is given as:

$$VR(2) = \frac{Var[r_t(2)]}{2Var[r_t]} = \frac{Var[r_t - r_{t-1}]}{2Var[r_t]} \tag{4-2}$$

$$VR(2) = \frac{Var[r_t] + 2Cov[r_t, r_{t-1}]}{2Var[r_t]} \tag{4-3}$$

$$VR(2) = 1 + \rho(1) \tag{4-4}$$

where $\rho(1)$ is autocorrelation coefficient of returns for first-order lagged value. To hold RWH true, there requires the autocorrelation coefficient, $\rho(1) = 0$ for variance ratio, $VR(2) = 1$. The $VR(2)$ can be further extended to any $q - period$ returns.

Lo and MacKinlay (1988) show that $q - period$ variance ratio satisfies the following relation:

$$VR(q) = \frac{Var[r_t(q)]}{q.Var[r_t]} = 1 + 2\sum_{k=1}^{q-1}\left(1 - \frac{k}{q}\right)\rho^k \tag{4-5}$$

Thus, for RWH to be true, the variance ratios at q period needs to be equal to 1. $VR(q) < 1$ implies negative autocorrelation while $VR(q) > 1$ indicates positive autocorrelation.

Based on $VR(q)$ estimator, Lo and MacKinlay (1988) proposed test statistics $M_1(q)$ under the null hypothesis of homoscedasticity, and $VR(q) = 1$, test statistic $M_1(q)$ is given as:

$$M_1(q) = \frac{VR(q) - 1}{\varphi(q)^{1/2}} \tag{4-6}$$

$M_1(q)$ follows an asymptotic standard normal distribution. The asymptotic variance, $\varphi(q)$, is given as.

$$\varphi(q) = \left(\frac{2(2q-1)(q-1)}{3q}\right)^2 \tag{4-7}$$

To accommodate the return series showing conditional heteroscedasticity, Lo and MacKinlay (1988) proposed another test statistic $M_2(q)$ which is heteroscedasticity-robust as:

$$M_2(q) = \frac{VR(q) - 1}{\varphi^*(q)^{1/2}} \tag{4-8}$$

$M_2(q)$ also follows an asymptotic standard normal distribution. The asymptotic variance $\varphi^*(q)$ is given as:

$$\varphi^*(q) = \sum_{j=1}^{q-1} \left(\frac{2(2q-1)}{q}\right)^2 \delta(j) \tag{4-9}$$

where

$$\delta(j) = \frac{\sum_{t=j+1}^{nq} (r_t - \hat{\mu})^2 \left(r_{t-j} - \hat{\mu}\right)^2}{\left[\sum_{t=1}^{nq} (r_t - \hat{\mu})^2\right]^2} \tag{4-10}$$

The decision rule for hypotheses testing of the standard normal distribution applies here in both homoscedastic, $M_1(q)$, and heteroscedastic increment, $M_2(q)$, tests.

4.3.2 Chow and Denning (1993) multiple variance test

The Lo and MacKinlay (1988) test is an individual VR test where the null hypothesis is tested for one-period. To determine the mean-reverting behaviour of a return series requires that the null hypothesis hold true for all $q - period$. Therefore, it is essential to conduct a joint test where a multiple comparison of VRs over $q - period$ is made. However, conducting separate individual tests for each period may be misleading as it leads to over rejection of the null hypothesis of a joint test, above the nominal size. Chow and Denning (1993) also emphasize that sequential testing procedure for each period separately leads to an oversized testing strategy. Thus, the weakness of Lo and MacKinlay (1988) test is that it ignores the joint nature of testing for the RWH.

To overcome this issue, Chow and Denning (1993) propose multiple VR test procedure where multiple variance ratios over numerous holding periods can be tested while controlling for overall test size.

Chow and Denning (1993) propose the test statistic for the homoscedastic version of the joint null of random walk hypothesis, as $CD_1(q)$ which is given as:

$$CD_1 = \sqrt{T}\, \max_{1 \le i \le m} |M_1(q_i)| \qquad i = 1,2, \dots, m \tag{4-11}$$

where $M_1(q_i)$ is based on the idea that the decision regarding the null hypothesis can be obtained from the maximum absolute value of the homoscedastic individual VR statistics. In order to control the size of the multiple VR test and because the limit distribution of these statistics is complex, Chow and Denning (1993) applied the Šidák (1967)'s probability inequality which gives an upper bound to the critical values taken in the studentized maximum modulus $SMM(\alpha, m, T)$ distribution, where m is the number of q-periods, T is for degree of freedom and α is for level of significance. The null hypothesis is rejected at α level of significance if the CD_1 statistic is greater than the SMM critical value, as tabulated by Hahn and Hendrickson (1971).

Similarly, heteroscedastic robust statistic of Chow and Denning (1993) is given as

$$CD_2 = \sqrt{T}\,\max_{1 \le i \le m} |M_2(q_i)| \qquad i = 1,2,\dots,m \tag{4-12}$$

where $M_2(q_i)$ is based on the idea that the decision regarding the null hypothesis can be obtained from the maximum absolute value of the heteroscedastic robust individual VR statistics, and it has the same critical values and decision rule, as CD_1.

4.3.3 Brock, Dechert and Scheinkman (BDS) test

To check the robustness, we employ a portmanteau test for time-based dependence in a series; it is popularly known as the Brock, Dechert and Scheinkman (or BDS) test, named after its authors. The test can be used to test against a variety of possible deviations from independence including linear dependence, nonlinear dependence, or chaos. To perform the test for a sample of n observations $x_1, \dots\dots.., x_n$, an embedding dimension m, and a distance ε, the correlation integral $C_m(n, \varepsilon)$ is estimated by

$$C_m(n,\varepsilon) = \frac{2}{(n-m)(n-m+1)} \sum_{s=1}^{n-m} \sum_{t=s+1}^{n-m+1} I_m(x_s, x_t, \varepsilon) \tag{4-13}$$

where

$$I_m(x_s, x_t, \varepsilon) = \prod_{k=0}^{m-1} I(x_{s+k}, x_{t+k}, \varepsilon) \tag{4-14}$$

and

$$I(x_s, x_t, \varepsilon) = \begin{cases} 1 \; if \; |x_s - x_t| < \varepsilon \\ 0 \; otherwise \end{cases} \tag{4-15}$$

The function $I(\cdot)$ indicates whether the observations at times s and t are near each other, as determined by the distance ε. The product $I_m(\cdot)$ is equals to one (1) when the two $m - period$ histories $(x_s, x_{s+1}, \dots, x_{x+m-1})$ and $(x_t, x_{t+1}, \dots, x_{t+m-1})$ are near each other in the sense that each term x_{s+k} is near x_{t+k}. The estimate of the correlation integral is the proportion of pairs of $m - period$ histories that are near each other.

The BDS considers the random variable $\sqrt{n}(C_m(n,\varepsilon) - C_1(n,\varepsilon)^m)$ which, for an $iid\ process$, converges to a normal distribution as n increases. The test statistic is given below.

$$W_m(\varepsilon) = \sqrt{\frac{n}{\hat{V}_m}}(C_m(n,\varepsilon) - C_1(n,\varepsilon)^m) \tag{4-16}$$

Where the consistent estimator of V_m namely, $\hat{V}_m$ is given by

$$\hat{V}_m = 4(k^m + (m-1)^2C^{2m} - m^2kC^{2m-2} + 2\sum_{j=1}^{m-1} k^{m-j}C^{2j} \tag{4-17}$$

With $C = C_1(n,\varepsilon)$ and

$$k = \frac{6}{(n-m-1)(n-m)(n-m+1)}\sum_{s=2}^{n-m}\left(\left[\sum_{r=1}^{s-1} I_m(x_r, x_s)\right]\left[\sum_{t=s+1}^{n-m+1} I_m(x_s, x_t)\right]\right) \tag{4-18}$$

The BDS test statistics is estimated at different m, and ε. The null of iid is rejected whenever the test statistics, $W_m(\varepsilon)$ is greater than the absolute critical value (i.e. Z-value).

4.4 Calendar anomalies in the International ETF returns

4.4.1 ARMA-GARCH Model

Prior to estimating ARMA-GARCH model, this study employs various diagnostic test on the return series of different days of the week and months of the year such as (1) Jarque-Bera test of normality, (2) Augmented Dickey-Fuller (ADF) test of unit root, Lagrange Multiplier (LM) test of ARCH effect and Pairwise Wilcoxon test to compare the distribution of returns on different days of the week and months of the year.

Specification of ARMA-GARCH Model

Autoregressive moving average (ARMA) models with autoregressive conditional heteroskedastic (ARCH) (Engle, 1982) or generalized autoregressive conditional heteroskedastic (GARCH) (Bollerslev, 1986) processes are the widely used approaches to modelling the mean and volatility of any time series in financial economics. GARCH models consider the moments of a time series as variant (i.e., the error term: real value minus forecasted value does not have zero mean and constant variance as with an ARMA process). For GARCH models, one of their advantages over ARCH models is parsimony which implies that fewer model parameters are needed to conduct the estimation. In the literature, the GARCH models frequently used are the general GARCH model (Garcia et al., 2005)

In this study, we use ARMA-GARCH model to determine calendar effect in the returns of international ETFs. The general linear ARMA (r, s) model for conditional mean is expressed as;

Mean equation

ARMA (r, s)

$$r_t = \mu + \sum_{i=1}^{r} \varphi_i r_{t-i} + \sum_{j=1}^{s} \phi_j \varepsilon_{t-j} + \sum_{k=1}^{t} \gamma_k D_{t-k} + \varepsilon_t \tag{4-19}$$

where r_t is the return series of international ETFs, μ is a constant, 'r' is the number of autoregressive orders, 's' is the number of moving average orders, φ_i is the i^{th} autoregressive coefficient, ϕ_j is the j^{th} moving average coefficient and ε_t is the error. D_{t-k} represents the five dummies when the model is estimated for days of the week effect (i.e. Monday to Friday) and the twelve dummies when the model is estimated for months of the year effect (i.e. January to December). γ_k is the j^{th} coefficient of the respective dummy.

In equation (4-19), the term $\mu + \sum_{j=1}^{r} \varphi_j r_{t-j} + \sum_{j=1}^{s} \phi_j \varepsilon_{t-j}$ is the deterministic component that presents the forecast of the current state as the functions of past observations and errors. The error term (ε_t) is the random component (i.e., innovations), which is commonly assumed to be zero mean and constant variance. However, in case, the error terms ε_t do not satisfy the homoscedastic assumption of constant variance, the time-varying (or conditional) variance assumption can be specified which is the function of lagged squared errors and past conditional variances. This phenomenon of time-varying variance can be observed in many time-series variables, especially in financial time-series data. Under such condition, the assumption of a constant variance of the disturbances in conventional econometric models, i.e., homoscedasticity is inappropriate. This implies that it is important to construct econometric models which can allow for the variance changes over time.

The time-varying (or conditional) variance (σt2) of the innovations (ε_t), is defined as;

Variance equation

Standard GARCH (p, q)

$$\sigma_t^2 = \omega + \sum_{i=1}^{p} \alpha_i \varepsilon_{t-i}^2 + \sum_{j=1}^{q} \beta_j \sigma_{t-j}^2 \tag{4-20}$$

In equation (4-20), ω is a constant, α_j is the ARCH parameter which represents the news about volatility from the previous period and β_j is the GARCH parameter which represents a persistence coefficient. If the sum of ARCH and GARCH coefficients $(\alpha_j + \beta_j)$ is close to unity, it implies that variability persist over a longer period. Moreover, if the sum is equal to (or greater than) unity, it implies the volatility tends to increase over time.

4.5 Returns and volatilities of International ETFs

4.5.1 DAILY returns and volatilities of international ETFs

ETF investors receive the NAV returns on their investments (Rompotis, 2015) while most of the retail investors calculate returns in trading price which are more frequently and easily available, compared to the NAVs. We, therefore, compute the returns of international ETFs both in trading prices and in NAVs to determine if there is any significant difference in the two returns series. Likewise, this study also examines the differences in volatilities of the trading price return and the NAV return. We calculate the returns and volatilities of benchmark indices to compare the performance of international ETFs and their corresponding benchmark indices.

The returns and volatilities of international ETFs in trading prices are computed as follows;

$$R_{ETF,t} = \log(CP_{ETF,t}) - \log(CP_{ETF,t-1}) \tag{4-21}$$

$$\sigma_{ETF} = \sqrt{\frac{\sum_{t=1}^{n}\left(R_{ETF,t} - \overline{R_{ETF}}\right)^2}{n-1}} \tag{4-22}$$

However, the returns and volatilities of international ETFs in NAVs are computed as follows;

$$R_{NAV,t} = \log(CP_{NAV,t}) - \log(CP_{NAV,t-1}) \quad (4\text{-}23)$$

$$\sigma_{NAV} = \sqrt{\frac{\sum_{t=1}^{n}\left(R_{NAV,t} - \overline{R_{NAV}}\right)^2}{n-1}} \quad (4\text{-}24)$$

Finally, the return and volatility of benchmark indices are computed as follows;

$$R_{Ind,t} = \log(CP_{Ind,t}) - \log(CP_{Ind,t-1}) \quad (4\text{-}25)$$

$$\sigma_{Ind} = \sqrt{\frac{\sum_{t=1}^{n}\left(R_{Ind,t} - \overline{R_{Ind}}\right)^2}{n-1}} \quad (4\text{-}26)$$

whereas $R_{ETF,t}$ is the ETF return in trading price estimated as the log difference between closing price at day t ($CP_{ETF,t}$) and closing price at day t-1 ($CP_{ETF,t-1}$); $R_{NAV,t}$ is the ETF return in NAVs estimated as the log difference between closing NAV at day t ($CP_{NAV,t}$) and closing NAV at day t-1 ($CP_{NAV,t-1}$); $R_{Ind,t}$ is the return of benchmark index estimated as the log difference between closing value at day t ($CP_{Ind,t}$) and closing value at day t-1 ($CP_{Ind,t-1}$). The corresponding risks associated with each return type are the return volatilities represented as σ_{ETF}, σ_{NAV} and σ_{Ind} which are measured as the standard deviations of the daily ETF return in trading prices, ETF return in NAVs and benchmark index return, respectively.

4.5.2 INTRADAY and OVERNIGHT return volatilities of international ETFs

In order to determine the difference between the volatilities during the trading and non-trading hours and to identify the cause of that difference, we compare the standard deviations of intraday and overnight returns of international ETFs. In previous literature (Chan, Chockalingam, & Lai, 2000; Rompotis, 2015; Tse & Martinez, 2007), the volatility in the assets traded on the stock markets is ascribed to one of the three reasons; the release of accumulated public information, more noise trading during the trading hours, or the release of more private information. To be more specific, the return volatility is either linked to the trading activity (e.g. the noise trading or the release of private information) or the information flow (e.g. the release of accumulated public information). The possible reason for the earlier relation is the synchronous trading hours while for the latter is due to the asynchronous trading hours between ETFs and their benchmark.

Therefore, if volatility is caused by the release of accumulated public information, overnight return volatility is greater than the intraday return volatility of ETFs, which are asynchronous in trading hours compared to their benchmarks indices; otherwise, for the case of synchronous trading hours between ETFs and their benchmarks, intraday return volatility is greater than overnight return volatility. If noise trading or release of private information ascribes the volatility, then intraday return volatility is greater than the overnight return volatility of ETFs.

The intraday returns and volatilities of international ETFs are calculated as:

$$R_{day} = \log(CP_{ETF,t}) - \log(OP_{ETF,t}) \tag{4-27}$$

$$\sigma_{day} = \sqrt{\frac{\sum_{t=1}^{n}\left(R_{day,t} - \overline{R_{day}}\right)^2}{n-1}} \tag{4-28}$$

The overnight returns and volatilities of international ETFs are calculated as:

$$R_{night} = \log(OP_{ETF,t}) - \log(CP_{ETF,t-1}) \tag{4-29}$$

$$\sigma_{night} = \sqrt{\frac{\sum_{t=1}^{n}\left(R_{night,t} - \overline{R_{night}}\right)^2}{n-1}} \tag{4-30}$$

where as $R_{day,t}$ is the intraday return estimated as the log difference between closing price of ETF at day t ($CP_{ETF,t}$) and opening price of ETF at day t ($OP_{ETF,t}$); $R_{night,t}$ is the overnight return estimated as the log difference between opening price of ETF at day t ($OP_{ETF,t}$) and closing price of ETF at day t-1 ($CP_{ETF,t-1}$); the corresponding risks, associated with each return type, are the return volatilities represented as σ_{day} and σ_{night} which are measured as the standard deviations of intraday and overnight returns, respectively.

4.6 Capital Asset Pricing Model (CAPM)

To evaluate the risk-adjusted performance of international ETFs, we employ the capital asset pricing model (CAPM). In addition, we, regress trading price return and NAV return of international ETFs on their corresponding benchmark return after adjusting them with a risk-free return in two separate models to examine the different behaviour of trading price returns and NAV returns in the CAPM model:

$$R_{ETF,t} - R_{rf,t} = \alpha + \beta_1 \left(R_{Ind,t} - R_{rf,t} \right) + \varepsilon_t \tag{4-31}$$

$$R_{NAV,t} - R_{rf,t} = \alpha + \beta_1 \left(R_{Ind,t} - R_{rf,t} \right) + \varepsilon_t \tag{4-32}$$

where $R_{ETF,t}$ represents ETF return on day t, $R_{rf,t}$ is the risk-free return represented by the one-month treasury bill rate, $R_{Ind,t}$ presents benchmark index return on day t, ε_t is the error term of the model and $alpha$ (α) is the coefficient which represents the extra return on ETF above its benchmark return. The coefficient $alpha$ (α) is not expected to be statistically significant due to the passive nature of the ETFs sample. This implies that the fund managers have very limited room to apply stock selection techniques. Thus, the expected $alpha$ (α) should not be different from zero, if ETF is efficiently priced in an efficient market. In any case, the positively significant $alpha$ (α) means ETF outperforms its benchmark; it further implies that despite the limited role, due to passive management, fund managers enable ETF to outperform its benchmark. However, the negatively significant $alpha$ (α) indicates that the ETF underperforms its benchmark. The cost and expenses of ETF are the potential reasons for its underperformance compared to its benchmark that is free from any kind of cost and expense.

The β_1 coefficient is the measure of ETFs' systematic risk and assesses the sensitivity ETF returns to the movements of its benchmark returns. In addition, β_1 is used to identify the replication strategies adopted by ETFs. If the β_1 coefficient does not differ from unity it implies that the respective ETF adopts a full replication strategy and if it is different from unity, the ETF departs from the full-replication strategy and either use an optimized or synthetic replication strategy.

4.7 Tracking ability

4.7.1 Measures of tracking ability

The term 'tracking error' refers to the deviation in returns of passively managed investment products and their benchmarks, whose performance they try to imitate (Pope & Yadav, 1994). The literature (Frino & Gallagher, 2001; Pope & Yadav, 1994; Roll, 1992) on the index funds suggests several methods to measure tracking error such as the average raw return difference between the passive funds and the indexes. Following Frino and Gallagher (2001), we use two methods to estimate tracking error. The first method estimates tracking error as the average term of the absolute differences in ETF and their benchmark returns. The second method computes tracking error as the standard deviation of the daily differences in ETF and their benchmark returns. Finally, we calculate the average of the tracking errors estimated using the two aforementioned methods.

Once the estimation tracking errors is completed using the trading price returns, it is repeated to estimate NAV returns. The purpose of calculating the tracking errors in trading price and NAV returns is to compare and determine which one of the two is superior in tracking their underlying indices.

Tracking errors estimated using trading price returns are given as:

$$TE1_{ETF,t} = \frac{\sum_{t=1}^{n} |R_{ETF} - R_{Ind}|}{n} \tag{4-33}$$

$$TE2_{ETF,t} = \sqrt{\frac{\sum_{t=1}^{n} [(R_{ETF} - R_{Ind}) - \overline{(R_{ETF} - R_{Ind})}]^2}{n-1}} \tag{4-34}$$

$$\overline{TE}_{ETF,t} = \frac{TE1_{ETF,t} + TE2_{ETF,t}}{2} \tag{4-35}$$

Tracking errors estimated using NAV returns are given as:

$$TE1_{NAV,t} = \frac{\sum_{t=1}^{n} |R_{NAV} - R_{Ind}|}{n} \tag{4-36}$$

$$TE2_{NAV,t} = \sqrt{\frac{\sum_{t=1}^{n} [(R_{NAV} - R_{Ind}) - \overline{(R_{NAV} - R_{Ind})}]^2}{n-1}} \tag{4-37}$$

$$\overline{TE}_{NAV,t} = \frac{TE1_{NAV,t} + TE2_{NAV,t}}{2} \tag{4-38}$$

where $R_{ETF,t}$ represents trading price return on day t; $R_{NAV,t}$ is the NAV return of on day t; $R_{Ind,t}$ presents benchmark index return on day t; $TE1_{ETF,t}$ is the average absolute difference between trading price return of ETFs and their corresponding benchmark returns; $TE2_{ETF,t}$ is the standard deviation of the difference between trading price return of ETFs and their corresponding benchmark returns; $\overline{TE}_{ETF,t}$ is the average of $TE1_{ETF,t}$ and $TE2_{ETF,t}$. However, $TE1_{NAV,t}$ is the average absolute difference between NAV return of ETFs and their corresponding benchmark returns; $TE2_{NAV,t}$ is the standard deviation of the difference between NAV return of ETFs and their corresponding benchmark returns; $\overline{TE}_{NAV,t}$ is the average of $TE1_{NAV,t}$ and $TE2_{NAV,t}$.

4.7.2 Second-order autoregressive model of tracking errors

Having computed the tracking error, we next investigate the persistence of tracking error in international ETFs. To examine the persistence, we estimate the second-order autoregressive model AR (2) by regressing the tracking error on the values of two lagged day as follows:

$$TE1_{ETF,t} = \alpha + \beta_1 TE1_{ETF,t-1} + \beta_2 TE1_{ETF,t-2} + \varepsilon_t \tag{4-39}$$

$$TE1_{NAV,t} = \alpha + \beta_1 TE1_{NAV,t-1} + \beta_2 TE1_{NAV,t-2} + \varepsilon_t \tag{4-40}$$

where $TE1_{ETF,t}$ is the average absolute difference between trading price return of ETFs and their corresponding benchmark returns and $TE1_{NAV,t}$ is the average absolute difference between NAV return of ETFs and their corresponding benchmark returns.

The positive and significant β_1 and β_2 coefficients imply that the tracking error persists for one and two days, respectively; while the negatively significant estimates mean that the tracking error exhibits mean-reverting behaviour. Finally, non-significant β_1 and β_2 coefficients show the lack of persistence and significant $alpha$ (α) indicates that a constant portion of replication inefficiency remains unexplained by the lagged values of tracking error.

4.8 Pricing Inefficiency

4.8.1 Measures of pricing inefficiency

The trading prices of international ETFs generally deviate from their NAVs (Delcoure & Zhong, 2007) and ETFs either trade at premium or discount to their NAVs. To measure the pricing efficiency in terms of premium and discount, we use two methods. First, we calculate the difference between the closing price of ETF on day t and the closing NAV of ETF on day t scaled by the closing NAV of ETF on day t.

$$Premium_t = \frac{CP_{ETF,t} - CP_{NAV,t}}{CP_{NAV,t}} \tag{4-41}$$

where $Premium_t$ represents the magnitude of premium or discount at which international ETFs trade on day t; $CP_{ETF,t}$ is the trading price of the international ETFs on day t and $CP_{NAV,t}$ is the respective NAV of the fund on the same day.

To measure the pricing discrepancies in international ETFs, we regress the trading price of ETF on its NAV using ordinary least square (OLS) method.

$$CP_{ETF,t} = \alpha + \beta_1 CP_{NAV,t} + \varepsilon_t \tag{4-42}$$

International ETF is efficiently priced if the β_1 coefficient is statistically significant and equals to one; and if it is statistically significant but different from unity then it indicates the pricing discrepancies in international ETFs. In particular, the significant and greater than one β_1 coefficient indicates that international ETFs trade at a discount to their NAVs; and the significant but less than one β_1 coefficient suggests that international ETFs trade at a premium to their NAVs.

4.8.2 Second-order autoregression model of pricing deviation

Finally, in order to examine how persistent is the pricing deviation in international ETFs, we regress the $Premium_t$ on its two day lagged values using the second-order autoregressive model AR (2).

$$Premium_t = \alpha + \beta_1 Premium_{t-1} + \beta_2 Premium_{t-2} + \varepsilon_t \tag{4-43}$$

where $Premium_t$ represents the magnitude of premium or discount at which international ETFs trade on day t.

4.9 Conclusion

This chapter presents the methodologies used in this study to examine the informational efficiency and performance of the international ETFs. We employ Lo and MacKinlay (1988) individual variance ratio and Chow and Denning (1993) multiple variance ratio to examine random walk in international ETF returns. The ARMA-GARCH model is used to investigate the presence and persistence of calendar anomalies in the international ETF returns over time. We estimate the return and volatility in trading price and NAV to distinguish their behaviour and to compare the return volatility during the trading hours (intraday) and non-trading hours (i.e. overnight), we also calculate and compare return and volatility during intraday and overnight periods. Moreover, to evaluate the risk-adjusted performance, we employ capital asset pricing model (CAPM) model by regressing trading price returns and NAV returns of International ETFs on their corresponding benchmark returns after adjusting both with a risk-free return. Tracking errors in trading price returns and NAV returns are estimated using two methods (1) the absolute difference in ETF and its benchmark returns and (2) the standard deviation of the difference in ETF and its benchmark returns; and second-order autoregressive model by regressing the tracking errors on the values of their two lagged days. To measure the pricing inefficiency of International ETFs, we use two methods (1) percentage change in closing price of ETFs and NAV and (2) OLS by regressing trading price of ETFs on its NAV and to examine the persistence of pricing inefficiency in International ETFs, we regress the estimated price deviation on its two day lagged values using the second-order autoregressive model.

Chapter 5

Empirical results

5.1 Introduction

This chapter reports and discusses the results of the study. Section 5.2, 5.3, 5.4, 5.5, 5.6, 5.7 present and discuss the findings related to the random walk, calendar anomalies, return and volatilities, risk-adjusted performance, tracking ability and pricing inefficiency of international ETFs, respectively. Section 5.8 summarizes and concludes the chapter.

5.2 Random walk of International ETFs

5.2.1 Descriptive statistics

Table 5-1 reports the descriptive statistics of the data. Penal A presents the statistics of ETFs tracking Asia-Pacific market indices, and Panel B is dedicated for the statistics of ETFs mirroring the performance of European markets.

Table 5-1: Descriptive statistics for daily returns of International ETFs

Table 5-1 shows the basic descriptive statistics of the return series of each ETF. The statistic includes mean, standard deviation, minimum, maximum, skewness, kurtosis and the results of Jarque-Bera (JB) test. The JB test is a goodness-of-fit measure of departure from normality. ***, **, * represent 1%, 5% and 10% level of significance, respectively.

Panel A: International ETFs tracking Asia-Pacific Indices

S#	ETF	Mean	Std. Dev	Min	Max	Skewness	Kurtosis	Jarque Bera test
1	AAXJ	0.006	1.812	-12.264	15.481	0.190	10.310	9252.46***
2	AIA	-0.010	1.835	-13.353	16.227	0.154	8.984	7516.58***
3	AXJV	-0.167	2.950	-47.091	3.643	-14.261	224.082	608220.28***
4	DVYA	0.025	1.724	-6.340	45.854	16.075	428.263	8945704.98***
5	ECNS	-0.023	1.674	-12.943	16.303	-0.230	12.185	9143.78***
6	EEMA	0.071	3.233	-7.140	101.511	27.157	849.801	34443394.75***
7	EIDO	0.003	1.894	-12.736	9.265	-0.216	3.692	902.08***
8	ENZL	0.022	1.199	-8.107	6.314	-0.440	3.063	648.96***
9	EPHE	0.018	1.434	-8.388	6.950	-0.264	2.889	522.05***
10	EPP	-0.002	1.843	-11.903	15.349	-0.055	8.428	7348.15***
11	EWA	0.002	2.076	-13.227	18.931	0.217	9.991	10260.27***
12	EWH	-0.020	2.089	-49.837	15.694	-5.739	144.279	2018958.62***
13	EWJ	-0.005	1.485	-10.990	15.856	0.251	11.388	12848.44***
14	EWM	-0.025	1.715	-30.768	8.606	-3.588	59.248	335139.95***
15	EWS	-0.022	1.958	-38.538	16.486	-3.118	68.810	467259.72***
16	EWT	-0.026	2.216	-59.140	13.239	-8.131	222.514	4764193.76***
17	EWY	-0.004	2.237	-14.876	20.230	0.427	13.517	18242.44***
18	FXI	-0.003	2.524	-16.070	27.845	0.763	13.393	17655.12***

S#	ETF	Mean	Std. Dev	Min	Max	Skewness	Kurtosis	Jarque Bera test
19	HEWJ	0.020	1.546	-8.540	7.414	-0.570	4.432	592.02***
20	INDA	-0.054	1.674	-25.844	6.265	-3.445	50.680	120903.97***
21	INDY	-0.023	1.638	-6.944	12.621	0.040	3.374	745.84***
22	IPAC	-0.003	1.018	-5.333	3.184	-0.516	2.702	222.33***
23	JPMV	0.003	1.026	-4.351	4.448	0.072	1.858	83.46***
24	JPXN	0.042	1.234	-5.535	4.747	-0.314	2.560	142.25***
25	MCHI	-0.006	1.534	-8.568	7.200	-0.187	2.729	445.86***
26	SCJ	0.003	1.437	-8.417	14.303	0.281	10.246	9662.35***
27	SMIN	0.045	2.181	-9.952	43.546	7.879	159.896	1059566.88***
28	THD	0.012	1.973	-12.395	14.374	-0.249	5.663	2776.71***
	Mean	**-0.004**	**1.827**	**-16.771**	**17.567**	**0.435**	**83.535**	

Panel B: International ETFs tracking European Indices

S#	ETF	Mean	Std. Dev	Min	Max	Skewness	Kurtosis	Jarque Bera test
29	EDEN	0.062	1.120	-7.835	4.351	-0.440	3.002	476.7***
30	EFNL	0.004	1.353	-10.625	5.752	-0.587	4.371	953.88***
31	EIRL	0.033	1.463	-12.104	8.799	-0.555	6.723	2936.63***
32	EIS	-0.006	1.521	-10.621	16.083	-0.116	10.589	10190.5***
33	ENOR	0.000	1.608	-9.778	18.726	0.906	18.119	15606.59***
34	EPOL	-0.018	1.865	-11.614	8.630	-0.542	4.215	1290.66***
35	ERUS	-0.025	2.185	-12.790	9.455	-0.466	2.951	606.21***
36	EUFN	-0.003	1.879	-18.104	12.062	-0.645	8.372	4892.22***
37	EUMV	-0.036	0.996	-9.285	3.125	-1.342	12.213	3901.88***
38	EWD	0.003	2.275	-14.679	30.086	0.626	17.284	30978.49***
39	EWG	0.001	1.858	-11.976	18.057	-0.023	8.843	7981.27***
40	EWGS	0.035	1.133	-6.529	5.417	-0.330	2.094	214.02***
41	EWI	-0.005	2.810	-16.199	89.395	13.179	424.545	18199057.99***
42	EWK	-0.034	1.892	-36.897	9.623	-3.549	64.000	414321.01***
43	EWL	0.006	1.438	-10.656	11.153	-0.587	7.975	6569.87***
44	EWN	-0.015	1.828	-21.326	13.429	-1.055	13.600	19122.26***
45	EWO	-0.003	2.484	-13.541	70.280	8.992	266.007	7191379.87***
46	EWP	0.010	2.875	-17.777	98.311	15.979	551.202	31538986.96***
47	EWQ	-0.004	1.960	-12.032	28.439	1.016	22.701	52995.11***
48	EWU	-0.011	1.755	-12.809	17.420	0.047	13.871	19367.28***
49	EWUS	-0.016	1.335	-17.011	4.822	-2.596	31.008	39471.6***
50	EZU	-0.015	1.881	-12.230	13.969	-0.193	6.800	4806.05***
51	HEWG	0.011	1.336	-7.924	4.323	-0.484	2.215	160.29***
52	HEZU	0.002	1.375	-9.630	4.095	-0.806	4.635	556.06***
53	IEUR	-0.035	1.164	-11.675	3.684	-1.708	15.619	6749.4***
54	IEUS	-0.011	1.204	-12.087	3.767	-1.899	17.275	7985.76***
55	IEV	0.002	1.903	-11.595	41.948	4.079	99.909	1030836.92***
56	TUR	-0.021	2.561	-16.193	18.719	-0.159	5.895	3184.6***
	Mean	**-0.003**	**1.752**	**-13.411**	**20.497**	**0.955**	**58.787**	

The average return and standard deviation of Panel-A ETFs in Table 5-1 are -0.004% and 1.827%, respectively. EEMA has the highest average returns of 0.071% while AXJV has the lowest average return of -0.167%. The returns of EEMA are mostly volatile, with a standard deviation of 3.233%, among the Asia-Pacific group of ETFs while the returns of IPAC exhibit the lowest volatility 1.018%. The results of skewness show that the distribution of returns is not symmetric around its means because the skewness is not equal to zero for any of the ETF. The result also shows 12 ETFs (16 ETFs) are positively (negatively) skewed indicating that the return distribution with an asymmetric tail extending toward more positive (negative) values. The results of kurtosis fails to confirm the normal distribution of the returns of Panel-A ETFs; because the kurtosis is not equal to 3 for any of the ETF. All 28 ETFs have positive kurtosis indicating the sharp peaks relative to the normal distribution. This non-normality of return distribution is further confirmed from the significant results of Jarque and Bera (1980) tests.

Turning to the European group of ETFs, the average return is -0.003% while the standard deviation is 1.752% on average. EDEN (EUMV) has the highest (lowest) average returns of 0.062% (-0.167%). The returns of EWP (EUMV) are the most (least) volatile, with a standard deviation of 3.233% (0.996%), among the European group of ETFs. Similar to the case of Asia-Pacific group of ETFs, the distribution of the returns of European group of ETFs is also not symmetric around its means because the skewness is not zero for any ETF. The returns distribution of 8 ETFs (20 ETFs) are positively (negatively) skewed. As far as the results of kurtosis are concerned, it not much different from the results of Panel-A ETFs. The kurtosis is not equal to three (03) for any of the ETF in Panel B, indicating that our data is not normally distributed. Out of 28 European group of ETFs, 25 ETFs have high kurtosis, signifying the sharp peaks relative to the normal distribution and only 3 ETFs have low kurtosis. In addition, the significant Jarque and Bera (1980) test statistic has also confirmed that the returns of Panel-B ETFs are not normally distributed.

5.2.2 Lo and MacKinlay individual variance ratio test

We also carry out Lo and MacKinlay (1988) individual VR test and estimate the corresponding test statistics of homoscedastic and heteroscedastic increment for each ETF returns for different time horizons.

Table 5-2: Lo and MacKinlay individual variance ratio test statistics for daily returns of international ETFs

Table 5-2 presents the results of Lo and MacKinlay individual variance ratio test. The results are presented as "*ratio *** (test statistics)*". ***, **, * represent 1%, 5% and 10% level of significance, respectively. Critical values for 1%, 5% and 10% are ±2.5758, ±1.9599 and ±1.6448, respectively.

Panel A: Lo and Mackinlay individual VR test statistics for daily returns of international ETFs tracking Asia-Pacific indices									
		M1 statistics (homoscedastic increment)				**M2 statistics (heteroscedastic increment)**			
S#	**ETFs**	**m=2**	**m=4**	**m=8**	**m=16**	**m=2**	**m=4**	**m=8**	**m=16**
1	AAXJ	0.937(-2.892)***	0.827(-4.209)***	0.731(-4.146)***	0.71(-3.01)***	0.937(-1.59)	0.827(-2.042)**	0.731(-1.967)**	0.71(-1.403)
2	AIA	0.877(-5.828)***	0.792(-5.252)***	0.692(-4.911)***	0.664(-3.599)***	0.877(-2.974)***	0.792(-2.555)**	0.692(-2.343)**	0.664(-1.717)*
3	AXJV	1.029(0.482)	1.047(0.424)	0.939(-0.348)	0.557(-1.69)*	1.029(1.995)**	1.047(1.582)	0.939(-0.972)	0.557(-4.87)***
4	DVYA	0.699(-10.26)***	0.552(-8.164)***	0.447(-6.366)***	0.415(-4.529)***	0.699(-19.344)***	0.552(-15.968)***	0.447(-11.404)***	0.415(-6.94)***
5	ECNS	1.013(0.491)	0.992(-0.155)	0.974(-0.338)	1.011(0.096)	1.013(0.18)	0.992(-0.06)	0.974(-0.143)	1.011(0.047)
6	EEMA	0.547(-15.254)***	0.338(-11.93)***	0.218(-8.913)***	0.17(-6.355)***	0.547(-22.136)***	0.338(-21.131)***	0.218(-19.405)***	0.17(-15.443)***
7	EIDO	1.051(2.01)**	0.986(-0.29)	0.832(-2.239)**	0.747(-2.27)**	1.051(1.278)	0.986(-0.192)	0.832(-1.533)	0.747(-1.613)
8	ENZL	0.904(-3.75)***	0.858(-2.958)***	0.818(-2.401)**	0.775(-1.995)**	0.904(-2.83)***	0.858(-2.095)**	0.818(-1.734)*	0.775(-1.526)
9	EPHE	1.041(1.548)	1.012(0.247)	0.907(-1.19)	0.901(-0.853)	1.041(1.233)	1.012(0.187)	0.907(-0.923)	0.901(-0.693)
10	EPP	0.882(-5.875)***	0.814(-4.948)***	0.754(-4.137)***	0.732(-3.036)***	0.882(-3.262)***	0.814(-2.553)**	0.754(-2.092)**	0.732(-1.513)
11	EWA	0.88(-5.94)***	0.821(-4.75)***	0.756(-4.094)***	0.684(-3.561)***	0.88(-3.368)***	0.821(-2.586)***	0.756(-2.188)**	0.684(-1.88)*
12	EWH	0.77(-11.033)***	0.646(-9.092)***	0.57(-6.981)***	0.549(-4.924)***	0.77(-7.221)***	0.646(-5.6)***	0.57(-4.29)***	0.549(-3.003)***
13	EWJ	0.866(-6.509)***	0.748(-6.544)***	0.655(-5.672)***	0.601(-4.414)***	0.866(-3.424)***	0.748(-3.115)***	0.655(-2.688)***	0.601(-2.102)**
14	EWM	0.87(-6.156)***	0.798(-5.127)***	0.748(-4.041)***	0.773(-2.444)**	0.87(-4.406)***	0.798(-3.883)***	0.748(-3.21)***	0.773(-1.978)**
15	EWS	0.806(-9.413)***	0.703(-7.679)***	0.658(-5.597)***	0.693(-3.373)***	0.806(-6.278)***	0.703(-4.683)***	0.658(-3.372)***	0.693(-2.023)**
16	EWT	0.775(-10.777)***	0.668(-8.5)***	0.553(-7.229)***	0.536(-5.046)***	0.775(-8.906)***	0.668(-6.592)***	0.553(-5.63)***	0.536(-3.949)***
17	EWY	0.922(-3.81)***	0.86(-3.641)***	0.804(-3.229)***	0.762(-2.643)***	0.922(-1.993)**	0.86(-1.638)	0.804(-1.392)	0.762(-1.115)
18	FXI	0.823(-8.526)***	0.716(-7.315)***	0.629(-6.047)***	0.589(-4.501)***	0.823(-4.294)***	0.716(-3.587)***	0.629(-2.975)***	0.589(-2.209)**
19	HEWJ	1.001(0.015)	0.965(-0.489)	0.844(-1.368)	0.706(-1.733)*	1.001(0.011)	0.965(-0.36)	0.844(-1.05)	0.706(-1.382)
20	INDA	0.849(-5.026)***	0.748(-4.469)***	0.661(-3.808)***	0.614(-2.917)***	0.849(-5.35)***	0.748(-4.778)***	0.661(-4.057)***	0.614(-3.086)***
21	INDY	0.92(-3.158)***	0.87(-2.757)***	0.857(-1.912)*	0.86(-1.261)	0.92(-2.297)**	0.87(-2.073)**	0.857(-1.494)	0.86(-1.025)
22	IPAC	1.017(0.437)	1.009(0.116)	0.887(-0.962)	0.772(-1.303)	1.017(0.298)	1.009(0.08)	0.887(-0.688)	0.772(-0.969)
23	JPMV	0.955(-1.075)	0.843(-1.994)**	0.717(-2.275)**	0.554(-2.411)**	0.955(-1.098)	0.843(-1.894)*	0.717(-2.06)**	0.554(-2.192)**
24	JPXN	0.901(-2.171)**	0.799(-2.365)**	0.694(-2.276)**	0.614(-1.925)*	0.901(-1.676)*	0.799(-1.795)*	0.694(-1.761)*	0.614(-1.538)
25	MCHI	1.021(0.79)	0.992(-0.156)	0.898(-1.294)	0.876(-1.057)	1.021(0.586)	0.992(-0.116)	0.898(-0.973)	0.876(-0.817)
26	SCJ	0.882(-5.543)***	0.784(-5.421)***	0.675(-5.142)***	0.657(-3.649)***	0.882(-2.593)***	0.784(-2.6)***	0.675(-2.585)***	0.657(-1.893)*
27	SMIN	0.775(-7.033)***	0.689(-5.205)***	0.626(-3.958)***	0.637(-2.584)***	0.775(-8.27)***	0.689(-6.12)***	0.626(-4.506)***	0.637(-2.827)***
28	THD	0.899(-4.584)***	0.859(-3.429)***	0.81(-2.908)***	0.81(-1.959)*	0.899(-2.595)***	0.859(-1.952)*	0.81(-1.672)*	0.81(-1.125)

Panel B: Lo and Mackinlay individual VR test statistics for daily returns of international ETFs tracking European indices									
		M1 statistics (homoscedastic increment)				M2 statistics (heteroscedastic increment)			
S#	ETFs	m=2	m=4	m=8	m=16	m=2	m=4	m=8	m=16
29	EDEN	0.936(-2.188)**	0.907(-1.696)*	0.816(-2.121)**	0.7(-2.323)**	0.936(-1.634)	0.907(-1.316)	0.816(-1.727)*	0.7(-1.973)**
30	EFNL	1.004(0.135)	0.996(-0.079)	0.856(-1.627)	0.799(-1.525)	1.004(0.127)	0.996(-0.067)	0.856(-1.359)	0.799(-1.294)
31	EIRL	0.979(-0.808)	0.938(-1.292)	0.741(-3.407)***	0.641(-3.169)***	0.979(-0.485)	0.938(-0.825)	0.741(-2.325)**	0.641(-2.292)**
32	EIS	0.898(-4.766)***	0.815(-4.612)***	0.791(-3.298)***	0.827(-1.83)*	0.898(-2.498)**	0.815(-2.23)**	0.791(-1.602)	0.827(-0.917)
33	ENOR	0.949(-1.7)*	0.892(-1.943)*	0.819(-2.052)**	0.729(-2.068)**	0.949(-1.433)	0.892(-1.684)*	0.819(-1.845)*	0.729(-1.922)*
34	EPOL	0.936(-2.602)***	0.874(-2.722)***	0.823(-2.422)**	0.777(-2.045)**	0.936(-1.907)*	0.874(-1.946)*	0.823(-1.739)*	0.777(-1.501)
35	ERUS	0.908(-3.587)***	0.894(-2.194)**	0.828(-2.262)**	0.831(-1.489)	0.908(-2.774)***	0.894(-1.624)	0.828(-1.666)*	0.831(-1.105)
36	EUFN	0.994(-0.233)	0.941(-1.278)	0.797(-2.773)***	0.693(-2.818)***	0.994(-0.149)	0.941(-0.804)	0.797(-1.823)*	0.693(-1.951)*
37	EUMV	0.986(-0.338)	0.997(-0.045)	0.796(-1.68)*	0.621(-2.097)**	0.986(-0.227)	0.997(-0.03)	0.796(-1.142)	0.621(-1.533)
38	EWD	0.867(-6.633)***	0.774(-6.01)***	0.665(-5.635)***	0.589(-4.646)***	0.867(-3.898)***	0.774(-3.559)***	0.665(-3.334)***	0.589(-2.739)***
39	EWG	0.947(-2.624)***	0.902(-2.579)***	0.835(-2.764)***	0.829(-1.924)*	0.947(-1.657)*	0.902(-1.497)	0.835(-1.551)	0.829(-1.052)
40	EWGS	0.993(-0.224)	0.915(-1.474)	0.8(-2.194)**	0.755(-1.807)*	0.993(-0.173)	0.915(-1.171)	0.8(-1.827)*	0.755(-1.54)
41	EWI	0.745(-12.527)***	0.61(-10.239)***	0.525(-7.881)***	0.499(-5.586)***	0.745(-15.255)***	0.61(-11.685)***	0.525(-8.847)***	0.499(-6.283)***
42	EWK	0.901(-4.824)***	0.853(-3.84)***	0.794(-3.414)***	0.828(-1.916)*	0.901(-3.001)***	0.853(-2.47)**	0.794(-2.223)**	0.828(-1.244)
43	EWL	0.895(-5.154)***	0.804(-5.164)***	0.712(-4.791)***	0.69(-3.461)***	0.895(-2.953)***	0.804(-2.879)***	0.712(-2.682)***	0.69(-1.936)*
44	EWN	0.883(-5.733)***	0.83(-4.474)***	0.77(-3.817)***	0.803(-2.206)**	0.883(-3.479)***	0.83(-2.603)***	0.77(-2.177)**	0.803(-1.254)
45	EWO	0.829(-8.397)***	0.743(-6.768)***	0.679(-5.35)***	0.665(-3.753)***	0.829(-6.883)***	0.743(-5.239)***	0.679(-4.124)***	0.665(-2.905)***
46	EWP	0.732(-13.353)***	0.587(-10.988)***	0.482(-8.711)***	0.435(-6.391)***	0.732(-16.582)***	0.587(-13.152)***	0.482(-10.239)***	0.435(-7.522)***
47	EWQ	0.882(-5.832)***	0.805(-5.157)***	0.724(-4.621)***	0.68(-3.598)***	0.882(-3.861)***	0.805(-3.292)***	0.724(-2.937)***	0.68(-2.278)**
48	EWU	0.891(-5.37)***	0.8(-5.243)***	0.695(-5.068)***	0.63(-4.127)***	0.891(-2.954)***	0.8(-2.755)***	0.695(-2.652)***	0.63(-2.136)**
49	EWUS	1.079(2.44)**	1.018(0.291)	0.85(-1.57)	0.783(-1.52)	1.079(0.727)	1.018(0.101)	0.85(-0.635)	0.783(-0.7)
50	EZU	0.905(-4.739)***	0.845(-4.117)***	0.768(-3.911)***	0.748(-2.848)***	0.905(-2.824)***	0.845(-2.375)**	0.768(-2.229)**	0.748(-1.608)
51	HEWG	1.023(0.58)	1.06(0.811)	1.016(0.138)	0.855(-0.842)	1.023(0.489)	1.06(0.695)	1.016(0.119)	0.855(-0.724)
52	HEZU	1.053(1.248)	1.056(0.7)	0.894(-0.839)	0.704(-1.575)	1.053(0.992)	1.056(0.567)	0.894(-0.69)	0.704(-1.32)
53	IEUR	0.972(-0.713)	0.972(-0.379)	0.79(-1.782)*	0.656(-1.958)*	0.972(-0.416)	0.972(-0.227)	0.79(-1.14)	0.656(-1.357)
54	IEUS	0.987(-0.313)	0.94(-0.797)	0.767(-1.94)*	0.708(-1.634)	0.987(-0.131)	0.94(-0.373)	0.767(-1.018)	0.708(-0.94)
55	IEV	0.826(-8.635)***	0.72(-7.432)***	0.627(-6.244)***	0.591(-4.612)***	0.826(-6.155)***	0.72(-5.012)***	0.627(-4.155)***	0.591(-3.057)***
56	TUR	0.956(-2.052)**	0.927(-1.831)*	0.884(-1.83)*	0.9(-1.067)	0.956(-1.249)	0.927(-1.107)	0.884(-1.087)	0.9(-0.631)

Panel A in Table 5-2 presents the results for ETFs tracking Asia-Pacific indices. The individual VR test statistics of the majority of ETFs reject the null hypothesis that the variance ratio is unity at given q-period. The rejection of the null hypothesis gets stronger as the q-period increases in the case of homoscedastic version of RWH but it gets weaker as the q-period increases in the case of heteroscedasticity-robust version of RWH. The variance ratios of all the statistically significant ETFs are less than one which indicates that returns of these ETFs are mean-reverting (or negatively correlated). The results of homoscedastic and heteroscedastic version of RWH are mostly similar, i.e. the null hypotheses are rejected for more than half of the ETFs in both cases.

Panel B in Table 5-2 shows homoscedastic and heteroscedastic test statistics of Lo and MacKinlay (1988) individual VR test for ETFs tracking European indices. The test statistics for both the versions of RWH are significant for half of the ETFs for all q-periods (i.e. 2, 4, 8 and 16) except for heteroscedastic version at q=16. The rejection of the null hypothesis is stronger at q=2 and q=8 and slightly weaker at q=4 and q=16 for both homoscedastic and heteroscedasticity robust RWH. The variance ratios are mostly less than one for all significant ETFs which exhibits their mean-reverting behaviour; however, there is one exception of an ETF, with a symbol EWUS, for which the variance ratio is greater than one at q=2. This implies that this ETF has a positive autocorrelation at q=2 but remain insignificant for other holding periods in case of homoscedastic RWH and for all holding periods of heteroscedastic RWH.

The inference can be drawn from the overall findings that the pricing of about half of the US-listed ETFs offering exposures of Asia-Pacific and European market indices do not follow a random walk.

5.2.3 Chow and Denning multiple variance ratio test

The results of Chow and Denning (1993) multiple VR test is quite similar to the results of Lo and MacKinlay (1988) individual VR test. The estimated corresponding test statistics of homoscedastic increments and heteroscedastic RWH at different q-periods (i.e. 2, 4, 8 and 16) are found to be greater than the critical values, at 10% significance level and better. Thus, it causes the rejection of null hypothesis. Table 5-3 presents the results of Chow and Denning (1993) multiple VR test.

Table 5-3: Chow and Denning variance ratio test statistics for daily returns of international ETFs

Table 5-3 presents the results of Chow and Denning multiple variance ratio test. The results are presented as "*test statistic *** (p-value)*". ***, **, * represent 1%, 5% and 10% level of significance, respectively.

Panel A: Multiple VR test statistics for daily returns of international ETFs tracking Asia-Pacific indices									
		CD1 (homoscedastic increment)				CD2 (heteroscedastic increment)			
S#	ETFs	hp2	hp4	hp8	hp16	hp2	hp4	hp8	hp16
1	AAXJ	2.892***	4.209***	4.146***	3.01***	1.59	2.042**	1.967**	1.403
2	AIA	5.828***	5.252***	4.911***	3.599***	2.974***	2.555**	2.343**	1.717*
3	AXJV	0.482	0.424	0.348	1.69*	1.995**	1.582	0.972	4.87***
4	DVYA	10.26***	8.164***	6.366***	4.529***	19.344***	15.968***	11.404***	6.94***
5	ECNS	0.491	0.155	0.338	0.096	0.18	0.06	0.143	0.047
6	EEMA	15.254***	11.93***	8.913***	6.355***	22.136***	21.131***	19.405***	15.443***
7	EIDO	2.01**	0.29	2.239**	2.27**	1.278	0.192	1.533	1.613
8	ENZL	3.75***	2.958***	2.401**	1.995**	2.83***	2.095**	1.734*	1.526
9	EPHE	1.548	0.247	1.19	0.853	1.233	0.187	0.923	0.693
10	EPP	5.875***	4.948***	4.137***	3.036***	3.262***	2.553**	2.092**	1.513
11	EWA	5.94***	4.75***	4.094***	3.561***	3.368***	2.586***	2.188**	1.88*
12	EWH	11.033***	9.092***	6.981***	4.924***	7.221***	5.6***	4.29***	3.003***
13	EWJ	6.509***	6.544***	5.672***	4.414***	3.424***	3.115***	2.688***	2.102**
14	EWM	6.156***	5.127***	4.041***	2.444**	4.406***	3.883***	3.21***	1.978**
15	EWS	9.413***	7.679***	5.597***	3.373***	6.278***	4.683***	3.372***	2.023**
16	EWT	10.777***	8.5***	7.229***	5.046***	8.906***	6.592***	5.63***	3.949***
17	EWY	3.81***	3.641***	3.229***	2.643***	1.993**	1.638	1.392	1.115
18	FXI	8.526***	7.315***	6.047***	4.501***	4.294***	3.587***	2.975***	2.209**
19	HEWJ	0.015	0.489	1.368	1.733*	0.011	0.36	1.05	1.382
20	INDA	5.026***	4.469***	3.808***	2.917***	5.35***	4.778***	4.057***	3.086***
21	INDY	3.158***	2.757***	1.912*	1.261	2.297**	2.073**	1.494	1.025
22	IPAC	0.437	0.116	0.962	1.303	0.298	0.08	0.688	0.969
23	JPMV	1.075	1.994**	2.275**	2.411**	1.098	1.894*	2.06**	2.192**
24	JPXN	2.171**	2.365**	2.276**	1.925*	1.676*	1.795*	1.761*	1.538
25	MCHI	0.79	0.156	1.294	1.057	0.586	0.116	0.973	0.817
26	SCJ	5.543***	5.421***	5.142***	3.649***	2.593***	2.6***	2.585***	1.893*
27	SMIN	7.033***	5.205***	3.958***	2.584***	8.27***	6.12***	4.506***	2.827***
28	THD	4.584***	3.429***	2.908***	1.959*	2.595***	1.952*	1.672*	1.125

Panel B: Multiple VR test statistics for daily returns of international ETFs tracking European indices									
		CD1 (homoscedastic increment)				CD2 (heteroscedastic increment)			
S#	ETFs	hp2	hp4	hp8	hp16	hp2	hp4	hp8	hp16
29	EDEN	2.188**	1.696*	2.121**	2.323**	1.634	1.316	1.727*	1.973**
30	EFNL	0.135	0.079	1.627	1.525	0.127	0.067	1.359	1.294
31	EIRL	0.808	1.292	3.407***	3.169***	0.485	0.825	2.325**	2.292**
32	EIS	4.766***	4.612***	3.298***	1.83*	2.498**	2.23**	1.602	0.917
33	ENOR	1.7*	1.943*	2.052**	2.068**	1.433	1.684*	1.845*	1.922*
34	EPOL	2.602***	2.722***	2.422**	2.045**	1.907*	1.946*	1.739*	1.501
35	ERUS	3.587***	2.194**	2.262**	1.489	2.774***	1.624	1.666*	1.105
36	EUFN	0.233	1.278	2.773***	2.818***	0.149	0.804	1.823*	1.951*
37	EUMV	0.338	0.045	1.68*	2.097**	0.227	0.03	1.142	1.533
38	EWD	6.633***	6.01***	5.635***	4.646***	3.898***	3.559***	3.334***	2.739***
39	EWG	2.624***	2.579***	2.764***	1.924*	1.657*	1.497	1.551	1.052
40	EWGS	0.224	1.474	2.194**	1.807*	0.173	1.171	1.827*	1.54
41	EWI	12.527***	10.239***	7.881***	5.586***	15.255***	11.685***	8.847***	6.283***
42	EWK	4.824***	3.84***	3.414***	1.916*	3.001***	2.47**	2.223**	1.244
43	EWL	5.154***	5.164***	4.791***	3.461***	2.953***	2.879***	2.682***	1.936*
44	EWN	5.733***	4.474***	3.817***	2.206**	3.479***	2.603***	2.177**	1.254
45	EWO	8.397***	6.768***	5.35***	3.753***	6.883***	5.239***	4.124***	2.905***
46	EWP	13.353***	10.988***	8.711***	6.391***	16.582***	13.152***	10.239***	7.522***
47	EWQ	5.832***	5.157***	4.621***	3.598***	3.861***	3.292***	2.937***	2.278**
48	EWU	5.37***	5.243***	5.068***	4.127***	2.954***	2.755***	2.652***	2.136**
49	EWUS	2.44**	0.291	1.57	1.52	0.727	0.101	0.635	0.7
50	EZU	4.739***	4.117***	3.911***	2.848***	2.824***	2.375**	2.229**	1.608

51	HEWG	0.58	0.811	0.138	0.842	0.489	0.695	0.119	0.724
52	HEZU	1.248	0.7	0.839	1.575	0.992	0.567	0.69	1.32
53	IEUR	0.713	0.379	1.782*	1.958*	0.416	0.227	1.14	1.357
54	IEUS	0.313	0.797	1.94*	1.634	0.131	0.373	1.018	0.94
55	IEV	8.635***	7.432***	6.244***	4.612***	6.155***	5.012***	4.155***	3.057***
56	TUR	2.052**	1.831*	1.83*	1.067	1.249	1.107	1.087	0.631

Panel A in Table 5-3 presents the results for ETFs tracking Asia-Pacific indices; the null hypothesis is rejected for over half of the ETFs at various holding periods. As the holding period increases, the rejection of the null hypothesis gets stronger for homoscedastic version of RWH while for the case of heteroscedasticity-robust version of RWH it gets weaker as the holding period increases. Panel B in Table 5-3 shows homoscedastic and heteroscedastic test statistics of Chow and Denning (1993) multiple VR test for Panel-B ETFs. The test statistics for both versions of RWH are significantly greater than the SMM critical values for over half of the ETFs for all q-periods (i.e. 2, 4, 8 and 16). The rejection of the null hypothesis is stronger at q=2 and q=8 and slightly weaker at q=4 and q=16 for both homoscedastic and heteroscedasticity-robust RWH.

Based on the overall results, we can conclude that the returns of more than half of the international ETFs are not randomly generated and can be predicted through technical analysis.

5.2.4 Brock, Dechert and Scheinkman (BDS) test

And to check the robustness, we lastly employed BDS test. The test is performed at various embedded dimensions (m) such as 2, 4, 6, 8, and 10 at various epsilons (i.e. standard deviations of residuals) such as 0.5, 0.75, 1, 1.25, and 1.5. The null hypothesis, for BDS test, is that return series are independent and identically distributed and rejection of the null implies that RWH does not pass the test. Table 5-4 shows the results of the BDS test.

Table 5-4: Brock-Dechert-Scheinkman (BDS) test statistics for daily returns of international ETFs

Table 5-4 presents the results of BDS test. The results are presented as "*test statistic****". ***, **, * represent 1%, 5% and 10% level of significance, respectively.

Panel A: BDS test statistics for daily returns of international ETFs tracking Asia-Pacific indices						
S#	**ETFs**	**eps[1] m=2**	**eps[2] m=4**	**eps[3] m=6**	**eps[4] m=8**	**eps[5] m=10**
1	AAXJ	9.307***	17.516***	22.989***	27.361***	29.912***
2	AIA	8.038***	16.465***	22.286***	27.041***	29.966***
3	AXJV	1.464	1.061	-3.068***	-11.229***	-58.206***
4	DVYA	3.855***	6.801***	8.65***	9.374***	9.458***

5	ECNS	6.597***	9.605***	12.17***	14.551***	16.17***
6	EEMA	4.964***	8.328***	9.467***	10.095***	10.781***
7	EIDO	7.051***	11.437***	14.951***	17.735***	19.371***
8	ENZL	3.816***	5.271***	6.691***	8.165***	9.014***
9	EPHE	6.18***	9.397***	11.405***	13.171***	14.51***
10	EPP	11.506***	21.493***	27.759***	32.232***	33.413***
11	EWA	11.06***	19.098***	25.203***	29.971***	32.055***
12	EWH	11.106***	18.094***	23.662***	27.291***	28.435***
13	EWJ	10.818***	16.089***	19.91***	22.707***	24.548***
14	EWM	10.156***	16.327***	21.093***	24.352***	24.76***
15	EWS	10.457***	19.937***	25.815***	29.099***	29.634***
16	EWT	8.763***	15.102***	20.203***	23.963***	25.451***
17	EWY	10.031***	18.198***	24.086***	28.477***	30.484***
18	FXI	10.61***	17.63***	23.409***	28.797***	31.883***
19	HEWJ	6.567***	10.446***	12.213***	13.733***	13.875***
20	INDA	3.522***	4.732***	4.977***	5.716***	6.185***
21	INDY	2.984***	5.338***	7.004***	8.124***	9.193***
22	IPAC	4.255***	7.394***	9.371***	10.814***	11.312***
23	JPMV	2.029**	2.127**	3.516***	4.1***	4.435***
24	JPXN	3.903***	6.515***	8.549***	9.545***	10.008***
25	MCHI	4.177***	5.919***	8.344***	10.041***	11.259***
26	SCJ	10.06***	14.253***	18.46***	21.659***	23.472***
27	SMIN	4.278***	6.595***	7.89***	8.351***	8.776***
28	THD	8.262***	15.291***	20.665***	24.24***	26.164***

Panel B: BDS test statistics for daily returns of international ETFs tracking European indices

S#	ETFs	eps[1] m=2	eps[2] m=4	eps[3] m=6	eps[4] m=8	eps[5] m=10
29	EDEN	4.699***	6.804***	7.99***	8.344***	8.293***
30	EFNL	2.413**	5.087***	7.09***	8.56***	9.435***
31	EIRL	6.573***	10.631***	14.291***	16.886***	17.936***
32	EIS	8.776***	14.79***	19.078***	22.622***	24.54***
33	ENOR	6.217***	9.318***	11.652***	11.95***	11.999***
34	EPOL	5.162***	7.897***	9.113***	10.586***	12.031***
35	ERUS	5.482***	11.286***	14.962***	17.569***	19.692***
36	EUFN	6.841***	13.266***	17.578***	19.301***	19.623***
37	EUMV	1.857*	3.391***	4.02***	4.608***	6.033***
38	EWD	11.531***	20.506***	25.984***	29.201***	30.694***
39	EWG	9.35***	15.388***	19.991***	23.427***	25.534***
40	EWGS	2.668***	5.361***	6.949***	8.301***	9.3***
41	EWI	9.831***	17.305***	21.615***	23.864***	24.426***
42	EWK	13.509***	21.899***	26.765***	28.954***	28.939***
43	EWL	11.585***	19.123***	23.129***	25.185***	26.27***
44	EWN	11.503***	20.025***	25.261***	27.917***	28.902***
45	EWO	14.012***	21.245***	25.02***	26.25***	26.395***
46	EWP	9.268***	16.312***	20.492***	22.236***	22.628***
47	EWQ	10.091***	18.424***	23.637***	26.81***	27.825***
48	EWU	10.462***	19.046***	24.593***	27.492***	28.48***
49	EWUS	6.095***	8.404***	8.962***	9.548***	9.331***
50	EZU	11.197***	19.217***	24.483***	27.221***	28.164***
51	HEWG	3.032***	7.49***	10.143***	11.357***	11.378***

52	HEZU	3.183***	6.496***	8.133***	8.341***	8.568***
53	IEUR	2.814***	5.589***	7.852***	9.795***	10.277***
54	IEUS	3.75***	5.271***	7.708***	8.983***	9.742***
55	IEV	10.916***	18.647***	22.668***	24.634***	25.32***
56	TUR	7.579***	13.282***	16.837***	19.719***	21.516***

According to the results of BDS test, the return series of all international ETFs, irrespective of the underlying foreign markets, fail to accept the RWH and confirm the dependence in the returns of international ETFs. In addition, RWH is also rejected when tested at various embedded dimensions and epsilons. These results of BDS test are consistent with the findings of (1) Lo and MacKinlay (1988) individual VR and (2) Chow and Denning (1993) multiple VR tests.

5.3 Calendar anomalies in the International ETF returns

5.3.1 Descriptive statistics and diagnostic tests

Descriptive statistics and diagnostic tests of the TRADING PRICE returns and NAV returns of International ETFs

Table 5-5 reports the descriptive statistics and diagnostic tests of trading price returns and NAV returns of International ETFs. These return series are also depicted in Figure 5-1 for all sample ETFs and across full sample period.

The mean and standard deviation of trading price returns are -0.0054% and 1.9350%, respectively. The results of skewness show that the distribution of trading price returns is not symmetric around its means and are positively skewed. Moreover, the excess kurtosis also confirms the non-normal distribution of the trading price returns. The positive kurtosis of trading price returns indicates the sharp peaks relative to the normal distribution. This non-normality of trading price return distribution is further confirmed from the significant results of JB tests. We further examine the trading price returns for unit root by employing the Augmented Dickey Fuller test of unit root. The results of ADF test reveals that trading price returns has no unit root and are stationary in nature. And to examine the ARCH effect in the trading price returns, we use Lagrange Multiplier test proposed by Engle (1982); the results of LM test indicate that the residuals obtained from the AR model are autocorrelated, which means the volatile behaviour of trading price returns is time dependent and thus GARCH approach is appropriate to estimate the conditional variance.

Table 5-5: Descriptive statistics of the TRADING PRICE returns and NAV returns

Table 5-5 shows the basic descriptive statistics of the trading price returns and NAV returns of all sample international ETFs. The statistic includes mean, standard deviation, total number of observations and the results of Jarque-Bera (JB) test, Augmented-Dickey Fuller (ADF) test and Lagrange Multiplier (LM) Autoregressive Conditional Heteroscedasticity (ARCH) test. ***, **, * represent 1%, 5% and 10% level of significance, respectively.

	Mean	SD	Skewness	Kurtosis	N	JB Test	ADF Test	LM ARCH Test
Trading price returns	-0.0054	1.9350	1.9667	67.8148	85326	1640.5838***	-45.3679***	6022.005***
NAV returns	-0.0048	1.7628	2.1284	76.9806	85326	2113.3880***	-45.0173***	5326.265***

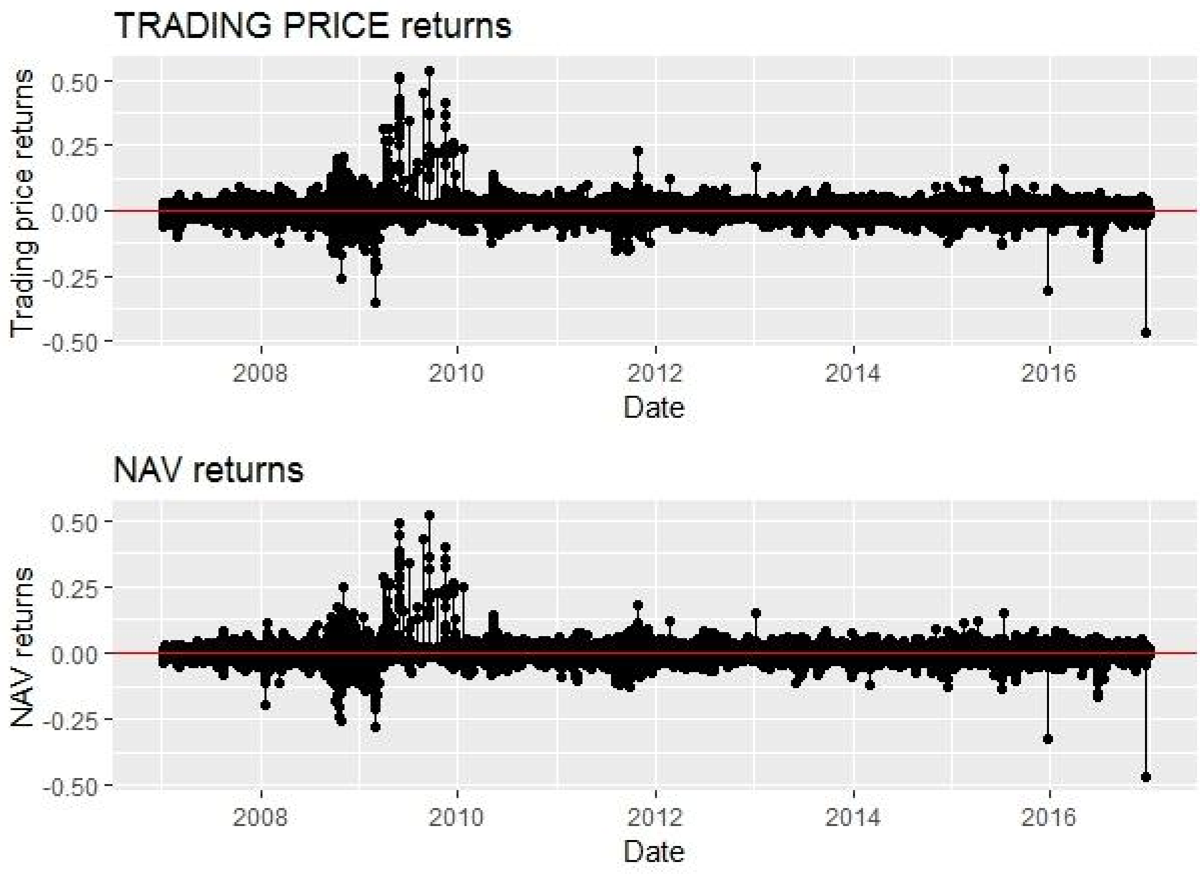

Figure 5-1: Trading price returns and NAV returns of International ETFs

On the other hand, the statistics and diagnostics of NAV returns are not too different from the trading price returns. The mean and standard deviation of NAV returns are -0.0048% and 1.7628% which are lower compare to the trading price returns. NAV return series is also found to have excess kurtosis and implying a leptokurtic series and is skewed to the left. In addition JB test also confirms the non-normality of NAV returns by statistically significant statistics at 1% significant level. Moreover, the presence of unit root in the NAV return series is also confirmed through statistically significant results of the ADF test and statistical significant results of LM ARCH test reveals that NAV returns has ARCH effect and thus ARCH/GARCH modelling is the appropriate approach to estimate the conditional variance in the case of NAV returns.

Descriptive statistics and diagnostic tests of the calendar anomalies

Table 5-6 reports the descriptive statistics and diagnostic tests of the trading price returns and NAV returns of International ETFs based on the week-of-the-days and months-of-the-years return distribution. Table 5-6 is further divided into two panels A and B for the results on trading price returns and NAV returns, respectively. Furthermore, each penal comprises of two sets of results related to the week-of-the-days and months-of-the-years return distribution.

Table 5-6: Descriptive statistics diagnostic tests of the calendar anomalies

Table 5-6 reports the descriptive statistics of the days-of-the-week and months of the year for full sample as well as regional and periodic subsamples of international ETFs.

	Mean	SD	Skewness	Kurtosis	N	Jarque-Bera Test	ADF Test	LM ARCH Test
Panel A: Descriptive statistics of the calendar anomalies in the TRADING PRICE returns of International ETFs								
(1) Days of the week								
Monday	-0.1296	2.1271	1.1448	67.0583	16072	301.5664***	-24.3142***	942.1783***
Tuesday	0.1067	2.1080	5.5324	106.1093	17527	831.3836***	-28.0745***	182.0208***
Wednesday	-0.0143	1.7613	-1.7105	42.7861	17465	134.1023***	-25.1106***	248.2531***
Thursday	0.0308	1.9070	2.3998	53.1189	17245	204.4505***	-30.054***	398.0813***
Friday	-0.0312	1.7396	0.0686	16.3987	17017	19.074***	-25.9849***	542.133***
(2) Months of the year								
January	-0.0870	1.7715	-0.0510	10.6330	6553	3.0897***	-20.371***	169.8553***
February	0.0833	1.5404	-0.5678	4.7174	6306	0.6192***	-22.164***	202.185***
March	0.0726	1.8010	-2.7281	60.5293	7243	111.5333***	-18.9342***	577.5604***
April	0.1450	1.5003	4.0125	69.2446	6943	140.6571***	-20.6783***	31.4901***
May	-0.0612	2.2544	9.6449	177.8647	7151	954.2441***	-20.2569***	8.1627
June	-0.1346	1.8368	-1.1941	8.3279	7324	2.2921***	-22.2218***	148.0533***
July	0.0784	1.5732	1.5428	39.0184	7269	46.4265***	-17.5453***	823.8981***
August	-0.1257	1.8949	1.0634	49.2157	7574	76.6259***	-22.104***	44.1358***
September	0.0105	2.2407	3.2841	77.4914	7041	177.5394***	-20.4962***	52.8072***
October	0.0520	2.4025	0.3891	16.8977	7460	8.8997***	-20.7307***	1580.9976***
November	-0.0655	2.2506	2.5690	41.5302	7029	51.318***	-20.8311***	226.9721***
December	-0.0192	1.7959	-1.8774	97.1487	7433	292.8979***	-19.5031***	11.9275
Panel B: Descriptive statistics of the calendar anomalies in the NAV returns of International ETFs								
(1) Days of the week								
Monday	-0.088	1.971	1.382	70.571	16072	334.107***	-23.116***	614.754***
Tuesday	0.046	1.906	5.625	116.69	17527	1003.862***	-30.3***	151.785***
Wednesday	0.015	1.564	-1.547	57.874	17465	244.497***	-27.205***	75.87***
Thursday	0.009	1.748	2.769	65.886	17245	314.193***	-25.665***	260.627***

Friday	-0.012	1.599	-0.102	22.523	17017	35.98***	-25.499***	537.43***
(2) Months of the year								
January	-0.084	1.696	-0.015	16.535	6553	7.47***	-19.35***	170.947***
February	0.095	1.456	-0.345	4.6095	6306	0.571***	-20.811***	213.11***
March	0.066	1.608	-2.226	51.068	7243	79.351***	-18.251***	533.869***
April	0.15	1.387	3.715	64.306	6943	121.3***	-20.065***	32.183***
May	-0.067	2.084	9.447	172.42	7151	896.887***	-19.468***	10.702
June	-0.136	1.699	-0.934	8.6516	7324	2.392***	-22.313***	322.55***
July	0.091	1.481	1.681	44.223	7269	59.611***	-17.665***	797.332***
August	-0.13	1.624	1.958	71.945	7574	163.921***	-22.391***	3.879
September	0.007	2.071	4.139	88.943	7041	234.232***	-20.586***	11.262
October	0.049	2.156	-0.627	20.347	7460	12.925***	-20.879***	966.2***
November	-0.081	1.92	3.718	68.523	7029	139.22***	-20.659***	65.212***
December	-0.004	1.692	-1.985	127.66	7433	505.486***	-19.425***	8.396

In Panel A, the statistics related to the days-of-the week reveals that the mean (standard deviation) of trading price returns on Monday is relatively lower (higher) compare to other days-of-the-week and thus supporting the Monday effect in the trading price return series. However, the statistics for the months-of-the-year shows no January effect in the trading price return, as mean return is negative in January. Instead, the mean (standard deviation) value of the trading price return is higher (lower) in April compare to other months-of-the year, indicating strong evidence of April effect in the trading price returns of international ETFs. On the other hand, in Panel B, Monday effect is there in the NAV return series with lower mean and higher standard deviation relative to other days-of-the-week and similar to trading price returns, the statistics of NAV returns also do not favour the January effect instead a strong evidence of April effect is revealed in NAV returns with higher mean and lower standard deviations compare to other months-of-the year.

Finally, the presence of non-normality, unit root and ARCH effect in both the trading price return and NAV returns based on days-of-the-week and months-of-the-year distribution is evident from the results of JB test, ADF test and LM ARCH test, respectively.

5.3.2 Pairwise Wilcoxon Test

Generally, a Kruskal-Wallis test is used to compare the mean of multiple groups to examine whether there is significant difference among the groups but this test does not give pairwise comparison. Therefore, for pairwise comparison of multiple groups such as weekdays and months we employ Pairwise Wilcoxon test. By using this test, we compare the returns generated on Monday with the returns generated on other days-of-the week and likewise we also compare the returns generated in January with returns generated in other months-of-the year. The results of Pairwise Wilcoxon tests is performed on both the returns estimated in trading price and NAV and are reported in the following

Table 5-7 which is further divided into two panels A and B for results related to trading price returns and NAV returns.

Table 5-7: Pairwise Wilcoxon tests

Table 5-7 reports the results of Pairwise Wilcoxon tests

Panel A: Trading price returns				Panel B: NAV returns			
Pairs	**P-values**	**Pairs**	**P-values**	**Pairs**	**P-values**	**Pairs**	**P-values**
Mon-Tue	0.0000	Jan-Feb	0.0000	Mon-Tue	0.0000	Jan-Feb	0.0000
Mon-Wed	0.0000	Jan-Mar	0.0000	Mon-Wed	0.0000	Jan-Mar	0.0000
Mon-Thu	0.0000	Jan-Apr	0.0000	Mon-Thu	0.0001	Jan-Apr	0.0000
Mon-Fri	0.0000	Jan-May	0.0005	Mon-Fri	0.0250	Jan-May	0.1457
		Jan-Jun	0.3520			Jan-Jun	0.2795
		Jan-Jul	0.0000			Jan-Jul	0.0000
		Jan-Aug	0.0566			Jan-Aug	0.2085
		Jan-Sep	0.0088			Jan-Sep	0.0237
		Jan-Oct	0.0000			Jan-Oct	0.0000
		Jan-Nov	0.0794			Jan-Nov	0.1645
		Jan-Dec	0.3520			Jan-Dec	0.0079

The results of Pairwise Wilcoxon test shows that the returns on Monday, regardless to their calculation in trading price and NAV, are significantly different from the returns of other days-of-the week. However, the return generated in January is significantly different from other months in most cases. But, for trading price returns, it is insignificant when compare to the returns generated in June and December and for NAV returns, the returns generated in May, June, August and November are insignificant. These insignificant results of pairwise comparison show that the mean value of the returns generated in the pairs of months (e.g. Jan-Jun) are not different from one another.

5.3.3 Results of Monday Effect

Table 5-8 reports the "Monday effect" in trading price returns and NAV returns of International ETFs into two Panels A and B, respectively. To ensure the robustness of the results, we not only divide the sample across the ETFs based on the underlying regions (i.e. Asia Pacific and Europe) but also over the time (i.e. full sample period 2007-20016 and year-wise subsamples). First, we analyse "Monday effect" in the returns of ALL ETFs, Asia Pacific ETFs and European ETFs. Second, we estimate the results for full sample period (i.e. 2007-2016) and then to examine the behaviour of calendar anomalies over the period of time, results are estimated for each year from 2007 to 2016.

The negative and significant coefficients on Monday returns indicates the existence of Monday effect while the positive and significant coefficients on Monday returns shows the complete reversal of Monday effect and insignificant coefficients on Monday returns means the absence of Monday effect in the returns of International ETFs. Figure 5-2 illustrates the change in coefficient on the returns generated on Monday which are estimated over the sample period.

Table 5-8: Monday effect in TRADING PRICE returns and NAV returns of International ETFs

Table 5-8 reports the results of Monday effect in trading price returns and NAV returns of International ETFs

	Panel A: Monday effect in Trading price returns			**Panel B: Monday effect in NAV returns**		
	All ETFs	**Asia Pacific ETFs**	**European ETFs**	**All ETFs**	**Asia Pacific ETFs**	**European ETFs**
2007-2016	-0.0572***	0.0001	0.0095	-0.0166*	0.0158	0.0237*
	(0.0000)	(0.9948)	(0.4649)	(0.0709)	(0.2008)	(0.0605)
2007	0.0775**	0.0991	0.041	0.108***	0.1307**	0.0556
	(0.0465)	(0.1533)	(0.3541)	(0.0008)	(0.0182)	(0.1647)
2008	-0.1613***	-0.1009	-0.0936	-0.1017*	-0.2325***	-0.1438**
	(0.0083)	(0.3106)	(0.1654)	(0.0816)	(0.004)	(0.022)
2009	0.1059	0.0824	0.319	0.454**	0.2259	0.1934
	(0.876)	(0.7839)	(0.7053)	(0.0392)	(0.3164)	(0.7675)
2010	0.121***	0.1605***	0.0844	0.0673*	0.1034**	0.1228**
	(0.0006)	(0.001)	(0.144)	(0.0521)	(0.0148)	(0.0358)
2011	0.0039	-0.0619	-0.0219	0.0052	-0.0254	-0.0327
	(0.9158)	(0.2423)	(0.7002)	(0.8903)	(0.5963)	(0.5761)
2012	0.1098***	0.0889**	0.0602	0.1059***	0.0665*	0.1217***
	(0.0002)	(0.0328)	(0.192)	(0.0000)	(0.0558)	(0.0055)
2013	0.0704***	-0.0442	0.0674**	0.0799***	-0.0164	0.1118***
	(0.0039)	(0.1963)	(0.0305)	(0.0006)	(0.6049)	(0.0001)
2014	-0.0062	0.003	-0.0344	-0.0086	0.0003	-0.0176
	(0.7706)	(0.9241)	(0.253)	(0.6682)	(0.9914)	(0.5203)
2015	-0.0512**	-0.0771**	-0.05	-0.0502**	-0.0747**	-0.0175
	(0.0288)	(0.0268)	(0.1334)	(0.0162)	(0.0133)	(0.5782)
2016	0.0207	0.0016	0.01	0.0031	-0.0024	0.0147
	(0.2848)	(0.9541)	(0.6974)	(0.8757)	(0.9329)	(0.5825)

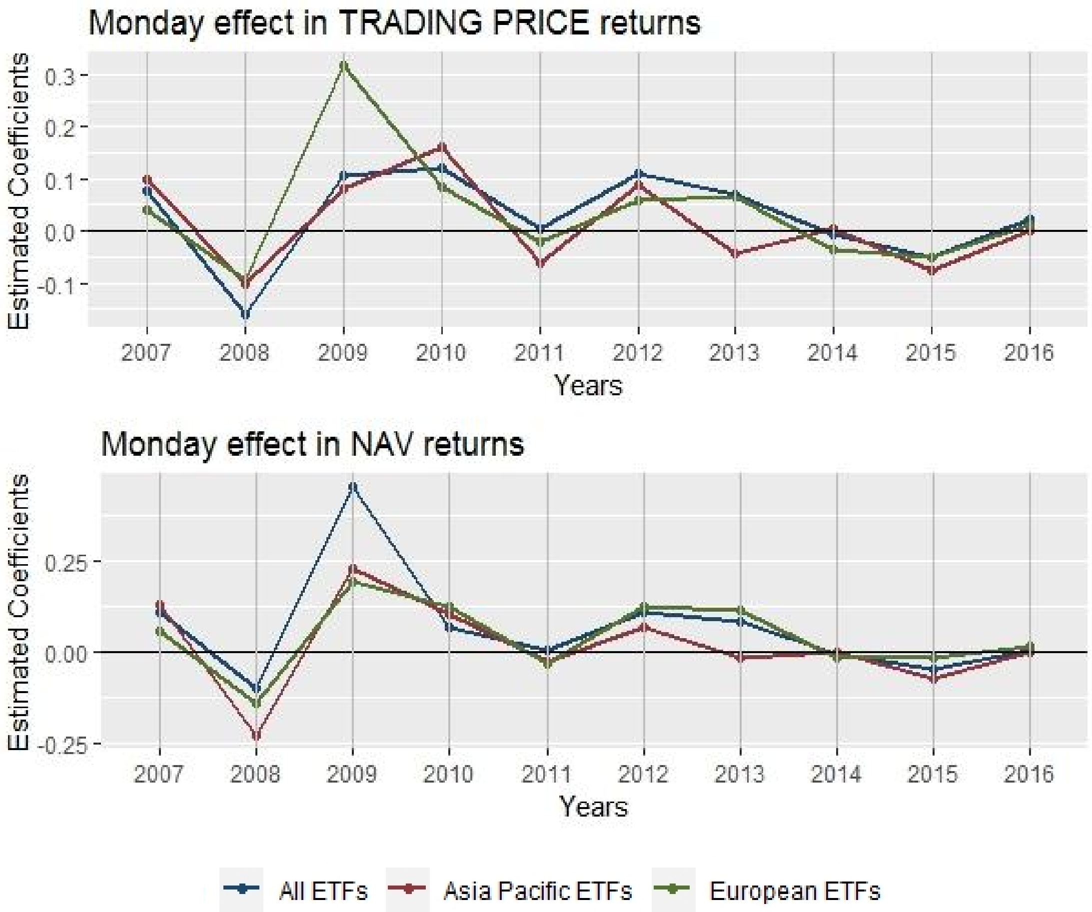

Figure 5-2: Monday effect in trading price returns and NAV returns

For brevity reasons, we only report the estimated parameters of "Monday effect" in the returns of ALL ETFs, Asia Pacific ETFs and European ETFs not only for full sample period but also for each year of the sample. However the detailed results of all days-of-the-week effect in trading price returns and NAV returns are tabulated in Appendix A and C, respectively.

In Panel A of Table 5-8, the full study period (i.e. 2007-2016) analyses of the trading price returns shows that Monday effect is present in ALL ETFs only and no such effect is observed in Asia Pacific and European ETFs. However, the year-wise analyses of trading price returns reveal variation in the Monday effect over the period of time. Monday effect is noted for (1) ALL ETFs in 2008 and 2015, (2) Asia Pacific ETFs in 2015 while European ETFs has no Monday effect in any year of the sample period. The complete reversal of Monday effect is observed for (1) ALL ETFs in 2007, 2010, 2012 and 2013, (2) Asia Pacific ETFs in 2010 and 2012, and (3) European ETFs in 2013.

However, in Panel B of Table 5-8, the full study period analyses of the NAV returns indicates significant "Monday effect" in ALL ETFs while no such effect is observed in Asia Pacific and the reversal of Monday effect is evident in European ETFs. In year-wise analyses of NAV returns, we found variation in the Monday effect over time. Monday effect is found significant for (1) ALL ETFs in 2008 and 2015, (2) Asia Pacific ETFs in 2008 and 2015 while (3) for European ETFs, Monday effect is statistically significant in 2008 only. The reversal of Monday effect is noted for (1) ALL ETFs in 2007, 2009, 2010, 2012 and 2013, (2) Asia Pacific ETFs in 2007, 2010 and 2012, and (3) European ETFs in 2010, 2012 and 2013.

5.3.4 Results of January Effect

Table 5-9 presents the results on "January effect" in the international ETF returns estimated in trading price and NAV into two Panels A and B, respectively. We follow similar method as in case of "Monday effect" and divide the sample into different subsamples across the ETFs and over the time period. "January effect" is first estimated in the returns of ALL ETFs, Asia Pacific ETFs and European ETFs and then in the subsamples comprises of full sample period (i.e. 2007-2016) and for each year from 2007 to 2016.

According to the "January effect", the returns generated in January are relatively higher than in other months-of-the-year. It was first documented by Rozeff and Kinney (1976) and thereafter it has gained much attention from academics as well as practitioners. The positively (negatively) significant coefficients on January returns indicates the existence (reversal) of "January effect" while the insignificant coefficients on January returns means the absence of January effect in the returns of international ETFs. Figure 5-3 illustrates the change in the coefficients on January returns estimated for each year of the sample period.

Table 5-9: January effect in TRADING PRICE returns and NAV returns of International ETFs

Table 5-9 reports the results of January effect of trading price returns and NAV returns of International ETFs

	January effect in Trading price returns			January effect in NAV returns		
	All ETFs	**Asia Pacific ETFs**	**European ETFs**	**All ETFs**	**Asia Pacific ETFs**	**European ETFs**
2007-2016	0.0035	0.0005	0.0206	-0.0215	0.0096	0.0308*
	(0.813)	(0.9759)	(0.25)	(0.1915)	(0.5866)	(0.0884)
2007	0.0523	0.1097	0.0441	0.0736**	0.1011*	0.0816**
	(0.1122)	(0.1309)	(0.379)	(0.0289)	(0.0666)	(0.0377)
2008	-0.0194	-0.1612**	-0.0911	-0.0822	-0.2644***	-0.0837
	(0.8219)	(0.0441)	(0.3636)	(0.3744)	(0.0038)	(0.4112)
2009	0.4106**	0.3962	0.6999	0.4919**	0.5305**	0.6518
	(0.0468)	(0.6272)	(0.4167)	(0.0115)	(0.026)	(0.5119)

2010	0.1178***	0.1962***	0.124	0.1066**	0.1972***	0.0854
	(0.0073)	(0.0002)	(0.2161)	(0.0231)	(0.0008)	(0.3194)
2011	-0.1357**	-0.0582	0.0476	-0.0986*	-0.0785	0.0705
	(0.0141)	(0.464)	(0.4603)	(0.0551)	(0.3696)	(0.2883)
2012	0.1312***	0.0898	0.15**	0.1209***	0.0708	0.1616**
	(0.0016)	(0.1417)	(0.0435)	(0.002)	(0.1795)	(0.0155)
2013	0.0724**	-0.0287	0.1139**	0.075**	0.0086	0.1259***
	(0.0432)	(0.4876)	(0.0173)	(0.0442)	(0.8134)	(0.0034)
2014	-0.0309	-0.0034	-0.0222	-0.0353	-0.0124	-0.0175
	(0.3993)	(0.9433)	(0.6643)	(0.3558)	(0.8109)	(0.7526)
2015	-0.0084	-0.0438	-0.0563	-0.0184	-0.0258	-0.0378
	(0.7873)	(0.4681)	(0.2137)	(0.5212)	(0.6071)	(0.4398)
2016	-0.0352	-0.0332	0.0691*	-0.0276	-0.0484	0.0579
	(0.2946)	(0.5563)	(0.0964)	(0.417)	(0.3425)	(0.1758)

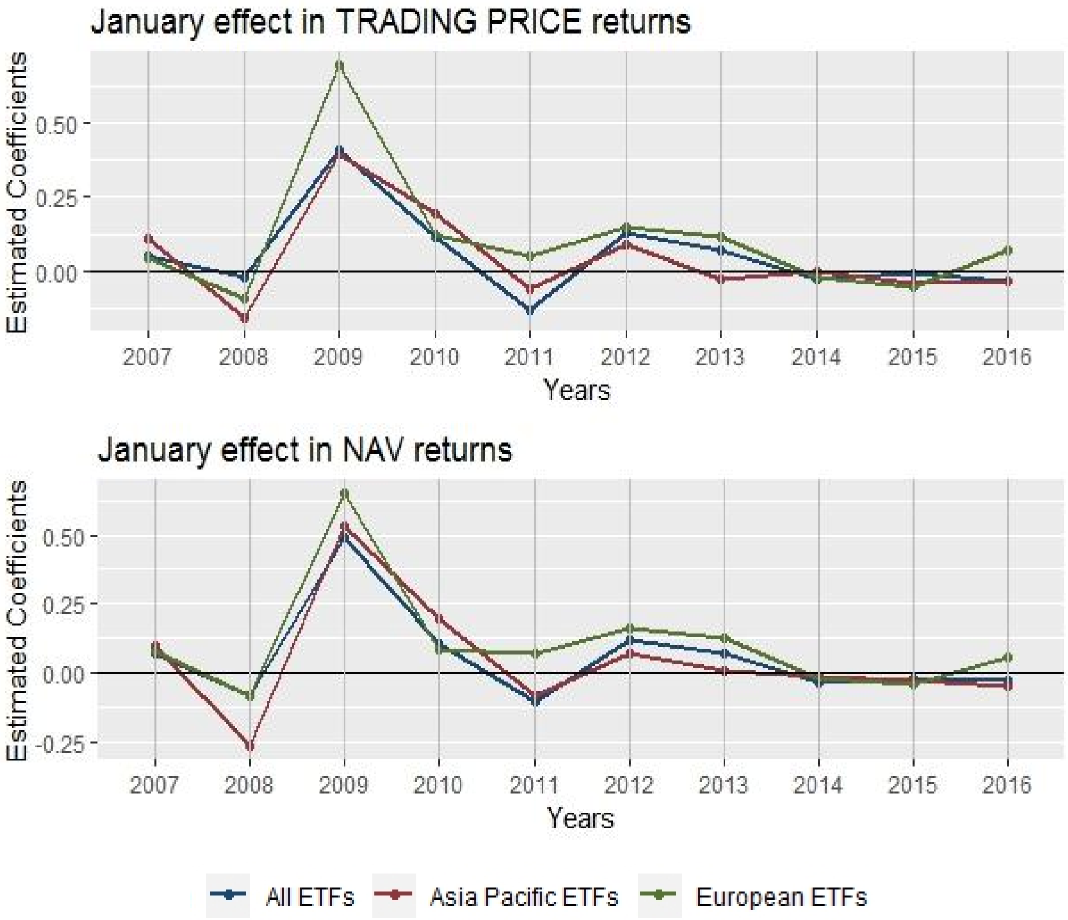

Figure 5-3: January effect in trading price returns and NAV returns

In Table 5-9, we only present the results on “January effect” in the returns of ALL ETFs, Asia Pacific ETFs and European ETFs. These results are not only for full sample period but also for each year of the sample. However the detailed results for each months-of-the-year effect in trading price returns and NAV returns are tabulated in Appendix B and D, respectively.

In Panel A of Table 5-9, the full study period (i.e. 2007-2016) analyses of the trading price returns fails to generate significant coefficients on January returns neither for ALL ETFs nor for Asia Pacific and European ETFs. However, the year-wise analyses of trading price returns reveal variation in the "January effect" over time. It is significant for (1) ALL ETFs in 2009, 2010, 2012 and 2013, (2) Asia Pacific ETFs in 2010 while for (3) European ETFs in 2012, 2013 and 2016. The complete reversal of "January effect" is noted for (1) ALL ETFs in 2011, (2) Asia Pacific ETFs in 2008, whereas the reversal of "January effect" is not observed in (3) European ETFs.

Moreover, the results of full study period analyses of the NAV returns reported in Panel B of the Table 5-9 indicate no significant "January effect" in ALL ETFs and Asia Pacific ETFs but strong evidence of "January effect" is noted in European ETFs. The year-wise analyses of NAV returns reveals significant January effect for (1) ALL ETFs in 2007, 2009, 2010, 2012 and 2013, (2) Asia Pacific ETFs in 2007, 2009 and 2010 while for (3) European ETFs in 2007, 2012 and 2013. The reversal of January effect is noted for (1) ALL ETFs in 2011, (2) Asia Pacific ETFs in 2008, and for (3) European ETFs, the reversal of "January effect" has not been noted for any year of the sample period.

Overall, the year-wise analyses of international ETFs returns, whether estimated in trading price or NAV, reflect a time-varying behaviour of "Monday effect" and "January effect". This shows that market efficiency evolves over time in a way consistent with the AMH.

5.4 Return and volatility analyses of International ETFs

Table 5-10 reports the return and volatility analyses of international ETFs. Panel A (Panel B) in Table 8 comprises the statistics of ETFs tracking the Asia-Pacific (the European) indices. The statistics reported in each panel includes the mean values of the trading price return(R_{ETF}), the NAV return(R_{NAV}), trading price return volatility(σ_{ETF}), the NAV return volatility(σ_{NAV}); and the two corresponding ratios, first between the trading price and the NAV returns (R_{ETF}/R_{NAV}) and second between the trading prices and the NAV return volatilities($\sigma_{ETF}/\sigma_{NAV}$). In addition, each panel also presents the mean values of the intraday return$\left(R_{day}\right)$, overnight return$\left(R_{night}\right)$, intraday return volatility$\left(\sigma_{day}\right)$, overnight return volatility$\left(\sigma_{night}\right)$; and a pair of corresponding ratios, first between the intraday and overnight returns $\left(R_{day}/R_{night}\right)$ and second between the intraday and overnight return volatilities$\left(\sigma_{day}/\sigma_{night}\right)$.

The first pair of ratios such as (R_{ETF}/R_{NAV}) and $(\sigma_{ETF}/\sigma_{NAV})$ is use to examine the behaviour of daily returns and return volatilities, estimated in trading prices and NAVs of international ETFs, respectively. If the ratio (R_{ETF}/R_{NAV}) is greater than one, it implies that the trading price return is higher than the NAV return and vice versa. On the other hand, if the ratio $(\sigma_{ETF}/\sigma_{NAV})$ is greater than unity, it means that the volatility in trading price return is higher than the NAV return volatility. The second pair of ratios of (R_{day}/R_{night}) and $(\sigma_{day}/\sigma_{night})$ help distinguish the intraday and overnight returns and return volatilities behaviour, respectively. If the ratio (R_{day}/R_{night}) is greater than one, it implies that intraday return is higher than overnight return and vice versa. However, if the ratio $(\sigma_{day}/\sigma_{night})$ is greater than unity, it means that intraday return volatility is higher than overnight return volatility.

In case of returns, our findings suggest that the trading price returns are higher than the NAV returns for the Asia-Pacific group of ETFs. This dominance of trading price returns for the Asia-Pacific group of ETFs, is also evident from the (R_{ETF}/R_{NAV}) ratio which is greater than one for 16 out of 28 ETFs. However, for the European group of ETFs, NAV returns are relatively better than the trading price returns, confirmed by the (R_{ETF}/R_{NAV}) ratio which is less than one for 15 out of 28 ETFs. Since investors receive NAV returns on their investments and our results suggests that NAV returns of the European group of ETFs are better compare to the Asia-Pacific group of ETFs. Therefore, it implies that the Asia-Pacific group of ETFs perform slightly worse than the European group of ETFs similar to Shin and Soydemir (2010)'s finding. As far as the return volatilities are concerned, the European group of ETFs are not too different from the Asia-Pacific group of ETFs because for both cases the trading price return volatilities are higher than the NAV return volatilities. This higher volatility in trading price returns of international ETFs is further verified by the higher $(\sigma_{ETF}/\sigma_{NAV})$ ratio which is greater than one for 24 out of 28 Asia-Pacific ETFs and 27 out of 28 European ETFs. These results are consistent with the findings of Pontiff (1997) on close-end funds and Rompotis (2015) on country ETFs; both reports that the trading prices are more volatile than their NAVs.

Table 5-10: Return and volatility analyses of International ETFs

Table 5-10 reports the return and volatility of international ETFs, estimated in trading prices and NAVs, and their corresponding tracking indices. It also contains the intraday and overnight return and volatility in trading prices of the International ETFs. The table also reports the four different ratios; (1) ratio between the trading price return and NAV return, (2) the ratio between the standard deviations (risks) of trading price return and NAV returns, (3) the ratio between intraday and overnight trading price returns, and (4) the ratio between the standard deviations (risks) of intraday and overnight trading price returns.

Panel A: Risk and Return Analysis of International ETFs tracking Asia-Pacific Indices

	Return							Risk						
ETF Tickers	R_{Ind}	R_{ETF}	R_{NAV}	$\frac{R_{ETF}}{R_{NAV}}$	R_{day}	R_{night}	$\frac{R_{day}}{R_{night}}$	σ_{Ind}	σ_{ETF}	σ_{NAV}	$\frac{\sigma_{ETF}}{\sigma_{NAV}}$	σ_{day}	σ_{night}	$\frac{\sigma_{day}}{\sigma_{night}}$
AAXJ	0.0147	0.0057	0.0051	1.1177	-0.0263	0.0478	-0.5505	1.3480	1.8024	1.3978	1.2895	1.2299	1.2612	0.9752
AIA	0.0050	-0.0034	-0.0027	1.2670	-0.1039	0.1186	-0.8758	1.4664	1.8199	1.4639	1.2432	1.2981	1.3876	0.9355
AXJV	-0.0045	-0.1460	-0.0835	1.7482	-0.0061	-0.1146	0.0532	0.7389	2.7437	1.9902	1.3786	0.2838	2.2407	0.1266
DVYA	0.0105	-0.0137	-0.0113	1.2122	-0.0372	0.0287	-1.2956	0.9359	1.0667	0.9544	1.1177	0.5913	0.8836	0.6693
ECNS	-0.0035	-0.0250	-0.0133	1.8843	0.0312	-0.0393	-0.7938	1.3546	1.6572	1.3653	1.2138	1.0824	1.4302	0.7568
EEMA	0.0060	-0.0175	-0.0030	5.8109	-0.0866	0.0800	-1.0825	0.9284	1.1715	0.9292	1.2607	0.7039	0.9811	0.7175
EIDO	0.0088	0.0037	0.0031	1.1905	-0.0533	0.0724	-0.7360	1.5188	1.8553	1.5158	1.2239	1.0980	1.3850	0.7928
ENZL	0.0499	0.0212	0.0283	0.7486	0.0164	0.0127	1.2887	1.0166	1.1888	1.0396	1.1436	0.7157	0.9400	0.7614
EPHE	0.0221	0.0167	0.0165	1.0097	-0.0228	0.0494	-0.4614	1.2189	1.4026	1.2115	1.1577	0.8673	1.0629	0.8160
EPP	0.0151	-0.0021	0.0002	-8.6858	0.0437	-0.0302	-1.4461	1.5315	1.8328	1.5412	1.1892	1.1720	1.3468	0.8702
EWA	0.0133	-0.0062	-0.0060	1.0225	0.0354	-0.0211	-1.6736	1.8007	2.0200	1.8135	1.1138	1.2603	1.6004	0.7875
EWH	0.0216	0.0074	0.0076	0.9766	0.0087	0.0126	0.6928	1.4215	1.7667	1.4284	1.2368	1.0744	1.3040	0.8239
EWJ	0.0022	-0.0060	-0.0055	1.0879	0.0405	-0.0363	-1.1143	1.4689	1.4528	1.4651	0.9917	0.8609	1.1339	0.7592
EWM	0.0156	-0.0112	-0.0113	0.9862	0.0420	-0.0407	-1.0331	1.0854	1.5865	1.2727	1.2466	0.9492	1.2637	0.7512
EWS	0.0112	-0.0053	-0.0051	1.0569	0.0271	-0.0182	-1.4836	1.4140	1.7394	1.4195	1.2253	1.0220	1.3636	0.7495
EWT	0.0143	-0.0001	0.0042	-0.0293	0.0583	-0.0428	-1.3613	1.4475	1.8026	1.4747	1.2223	1.0362	1.4557	0.7119
EWY	0.0102	0.0035	0.0036	0.9627	0.0123	0.0123	1.0030	1.9534	2.1830	1.9461	1.1217	1.1919	1.6874	0.7063
FXI	0.0103	-0.0043	-0.0037	1.1515	0.0310	-0.0105	-2.9622	2.0304	2.4126	2.0280	1.1896	1.3963	1.7383	0.8032
HEWJ	0.0317	0.0166	0.0227	0.7311	0.0198	0.0098	2.0199	1.4318	1.5175	1.5110	1.0043	0.6981	1.3876	0.5031
INDA	0.0079	-0.0112	0.0025	-4.4888	-0.0576	0.0586	-0.9830	1.2234	1.4557	1.2180	1.1952	0.8425	1.2367	0.6813
INDY	-0.0060	0.0063	0.0058	1.0794	-0.0289	0.0457	-0.6329	1.3047	1.5950	1.3055	1.2217	0.8444	1.2338	0.6844
IPAC	0.0070	-0.0048	-0.0031	1.5413	0.0156	-0.0155	-1.0073	1.0426	1.0090	1.0505	0.9605	0.5414	0.8246	0.6566
JPMV	0.0261	0.0034	0.0176	0.1954	0.0120	-0.0017	-7.2854	1.1188	1.0081	1.1212	0.8991	0.3882	0.9197	0.4221

JPXN	0.0772	-0.0052	-0.0029	1.7974	0.0556	-0.0517	-1.0771	1.5039	1.4209	1.4852	0.9567	0.8857	1.1415	0.7759
MCHI	0.0014	-0.0131	-0.0101	1.2887	-0.0238	0.0253	-0.9438	1.3710	1.5244	1.3766	1.1074	0.7736	1.3015	0.5943
SCJ	0.0203	0.0055	0.0099	0.5538	-0.0268	0.0497	-0.5383	1.3548	1.4389	1.3554	1.0616	1.1703	1.2706	0.9211
SMIN	0.0279	0.0182	0.0213	0.8558	-0.1324	0.1762	-0.7516	1.3390	1.6452	1.3640	1.2061	1.2637	1.5089	0.8375
THD	0.0287	0.0164	0.0167	0.9861	-0.0075	0.0410	-0.1833	1.5518	1.9259	1.5563	1.2375	1.0921	1.4930	0.7315
Mean:	**0.0159**	**-0.0054**	**0.0001**	**0.6807**	**-0.0058**	**0.0149**	**-0.9005**	**1.3543**	**1.6445**	**1.4143**	**1.1577**	**0.9405**	**1.3137**	**0.7258**

Panel B: Risk and Return Analysis of International ETFs tracking European Indices

	Return							Risk						
	R_{Ind}	R_{ETF}	R_{NAV}	$\frac{R_{ETF}}{R_{NAV}}$	R_{day}	R_{night}	$\frac{R_{day}}{R_{night}}$	σ_{Ind}	σ_{ETF}	σ_{NAV}	$\frac{\sigma_{ETF}}{\sigma_{NAV}}$	σ_{day}	σ_{night}	$\frac{\sigma_{day}}{\sigma_{night}}$
EDEN	0.0600	0.0586	0.0542	1.0804	-0.0079	0.0723	-0.1088	1.0947	1.1111	1.0953	1.0145	0.6712	1.0026	0.6695
EFNL	0.0312	-0.0004	0.0205	-0.0206	0.0041	0.0005	8.2296	1.3220	1.3396	1.3383	1.0010	0.7322	1.2041	0.6081
EIRL	0.0396	0.0338	0.0300	1.1262	-0.0208	0.0638	-0.3253	1.3750	1.4457	1.3542	1.0676	1.0092	1.2742	0.7920
EIS	0.0082	-0.0032	-0.0047	0.6761	-0.0070	0.0150	-0.4670	1.2542	1.5143	1.2598	1.2020	0.9798	1.1429	0.8573
ENOR	0.0008	-0.0155	-0.0125	1.2349	-0.0262	0.0231	-1.1333	1.4562	1.4869	1.4659	1.0143	0.8319	1.2427	0.6694
EPOL	-0.0022	-0.0186	-0.0197	0.9480	0.0220	-0.0264	-0.8335	1.6528	1.8500	1.6437	1.1255	1.1024	1.3419	0.8216
ERUS	-0.0097	-0.0252	-0.0260	0.9685	0.0104	-0.0144	-0.7197	1.9237	2.1649	1.8951	1.1424	1.3493	1.5196	0.8879
EUFN	-0.0001	-0.0041	-0.0125	0.3233	-0.0700	0.0810	-0.8640	1.7794	1.8529	1.7803	1.0408	1.0337	1.5439	0.6695
EUMV	-0.0141	-0.0328	-0.0249	1.3159	-0.0026	-0.0240	0.1092	0.9648	0.9773	0.9694	1.0081	0.5046	0.8325	0.6061
EWD	0.0085	-0.0050	-0.0046	1.0933	0.0517	-0.0354	-1.4598	2.0166	2.1765	2.0286	1.0729	1.3666	1.5704	0.8702
EWG	0.0087	-0.0010	0.0007	-1.4794	0.0273	-0.0115	-2.3738	1.7303	1.8361	1.7298	1.0614	1.2214	1.4185	0.8610
EWGS	0.0448	0.0320	0.0385	0.8296	0.0155	0.0271	0.5724	1.1471	1.1188	1.1501	0.9728	0.7701	1.0977	0.7016
EWI	-0.0276	-0.0403	-0.0394	1.0252	-0.0030	-0.0172	0.1714	1.9982	2.0998	1.9843	1.0582	1.2954	1.5525	0.8344
EWK	-0.0016	-0.0156	-0.0158	0.9916	0.0405	-0.0425	-0.9524	1.5804	1.6962	1.5619	1.0860	1.1268	1.2387	0.9096
EWL	0.0137	0.0064	0.0065	0.9946	0.0332	-0.0170	-1.9504	1.2925	1.3976	1.2801	1.0918	0.9597	1.0483	0.9155
EWN	0.0088	-0.0037	-0.0018	2.1127	0.0413	-0.0308	-1.3390	1.6115	1.7472	1.6089	1.0860	1.1247	1.2895	0.8722
EWO	-0.0240	-0.0321	-0.0322	0.9976	0.0649	-0.0773	-0.8388	1.9049	1.9991	1.8652	1.0718	1.3383	1.5164	0.8826
EWP	-0.0101	-0.0283	-0.0286	0.9904	0.0674	-0.0756	-0.8918	1.9736	2.0746	1.9280	1.0760	1.2769	1.5622	0.8174
EWQ	-0.0015	-0.0131	-0.0114	1.1479	0.0310	-0.0282	-1.1005	1.7648	1.8523	1.7670	1.0482	1.1961	1.3840	0.8642
EWU	0.0007	-0.0170	-0.0166	1.0229	0.0338	-0.0368	-0.9169	1.5778	1.6847	1.5841	1.0635	1.1289	1.2521	0.9016
EWUS	0.0377	-0.0142	0.0240	-0.5895	0.0361	-0.0414	-0.8716	1.2383	1.3149	1.2408	1.0597	0.6905	1.1761	0.5871
EZU	-0.0035	-0.0162	-0.0146	1.1149	0.0255	-0.0261	-0.9781	1.7182	1.8674	1.7206	1.0853	1.2033	1.3499	0.8914
HEWG	0.0275	0.0112	0.0119	0.9461	-0.0334	0.0566	-0.5893	1.2853	1.3191	1.2820	1.0289	0.8626	1.2496	0.6903

HEZU	0.0228	0.0037	0.0091	0.4111	-0.0190	0.0361	-0.5255	1.3101	1.3485	1.3305	1.0135	0.7614	1.1456	0.6646
IEUR	-0.0228	-0.0318	-0.0317	1.0034	-0.0364	0.0117	-3.1140	1.1332	1.1521	1.1359	1.0143	0.6610	0.9619	0.6872
IEUS	-0.0021	-0.0057	-0.0048	1.1918	-0.0688	0.0747	-0.9214	1.1168	1.5626	1.3065	1.1960	1.1339	1.4331	0.7912
IEV	0.0013	-0.0122	-0.0101	1.2097	0.0313	-0.0300	-1.0419	1.5689	1.6888	1.5692	1.0762	1.0990	1.2312	0.8926
TUR	-0.0098	-0.0180	-0.0208	0.8684	0.0123	-0.0029	-4.2349	2.1993	2.5522	2.2002	1.1600	1.5997	1.8357	0.8714
Mean:	**0.0066**	**-0.0074**	**-0.0049**	**0.8405**	**0.0090**	**-0.0027**	**-0.6953**	**1.5354**	**1.6511**	**1.5384**	**1.0692**	**1.0368**	**1.3006**	**0.7888**

With respect to the intraday and overnight returns and return volatilities estimated in trading prices of International ETFs, we find that intraday returns of international ETFs are lower than the overnight returns. This superiority of overnight returns is confirmed by the (R_{day}/R_{night}) ratio that is less than one for 25 out of 28 Asia-Pacific and 27 out of 28 European group of ETFs. However, in the case of intraday and overnight return volatilities, the intraday return volatility is smaller than the overnight return volatility. The higher overnight return volatilities are also confirmed by the $(\sigma_{day}/\sigma_{night})$ ratio which is less than one for all ETFs in the sample offering exposure of the Asia-Pacific and the European markets. Based on our findings, we can conclude that the release of accumulated public information during the trading hours is the reason for higher overnight return volatility compare to the intraday return volatility of international ETFs with asynchronous trading hours as their underlying indices.

5.5 Risk-adjusted performance analyses of International ETFs

Table 5-11 presents the results of the Capital Asset Pricing Model (CAPM) by regressing the excess returns of international ETFs on the excess returns of their corresponding underlying indices. In particular, the table reports the parameters estimated by the CAPM models based on each of the dependent variables (i.e. trading price return and NAV return). The table is divided into Panel A and B; Panel A (B) posts the results for ETFs offering exposure to the Asia-Pacific (the European) markets. Moreover, the parameters reported in the table include alpha coefficient, beta coefficients and the adjusted coefficient of determination (i.e. $\boldsymbol{Adj.R^2}$).

Based on Table 5-11 results, all international ETFs of the sample, irrespective of the markets they invest in, do generate positive and significant active return (i.e. α). More specifically, the number of $alpha\ (\alpha)$ coefficients estimated by the CAPM model based on NAV returns, are mostly negative and significant. However, all $alpha\ (\alpha)$ coefficients estimated by the CAPM model based on trading price returns (with one exception) are negative but very few are significant. The negatively significant $alpha\ (\alpha)$ coefficients indicate the underperformance of international ETFs relative to their tracking indices. There could be two possible reasons for this underperformance. First is the trading costs and taxes incurred on ETFs however, their benchmarks are free from such costs and second is the passive nature of sample ETFs, as the function of passively managed funds mirror the performance of their benchmarks and not to outperform them.

Table 5-11: Regression results of CAPM model

Table 5-11 reports the results of model (11): $R_{ETF,t} - R_{rf,t} = \alpha + \beta_1(R_{Ind,t} - R_{rf,t}) + \varepsilon_t$ and model (12): $R_{NAV,t} - R_{rf,t} = \alpha + \beta_1(R_{Ind,t} - R_{rf,t}) + \varepsilon_t$. Panel A (Panel B) reports the results of ETFs tracking the Asia-Pacific (European) markets. The standard errors for estimated coefficients, are heteroscedasticity and autocorrelation consistent standard errors (Newey & West, 1986) that are not reported here for the sake of brevity. "***", "**", and "*", represents the significance at 1%, 5%, and 10% level, respectively.

Panel A: Results for International ETFs tracking Asia-Pacific Indices

	Dependent variable: $(R_{ETF} - R_{rf})$			**Dependent variable**: $(R_{NAV} - R_{rf})$		
	α	β_1	$Adj. R^2$	α	β_1	$Adj. R^2$
AAXJ	-0.0184	0.7343***	0.3025	-0.011	0.9487***	0.8391
AIA	-0.0547	0.632***	0.2616	-0.0117***	0.9939***	0.9874
AXJV	-0.1726	0.7346***	0.0341	-0.0765	1.0682***	0.1555
DVYA	-0.0246	0.7751***	0.4680	-0.0218***	1.0033***	0.9677
ECNS	-0.0224	0.8008***	0.4375	-0.01*	0.9938***	0.9719
EEMA	-0.0165	0.7879***	0.3882	-0.0091***	0.9956***	0.9894
EIDO	-0.0096	0.7695***	0.3963	-0.0058***	0.9962***	0.9964
ENZL	-0.0174	0.7774***	0.4416	-0.0222***	0.9897***	0.9348
EPHE	-0.0047	0.648***	0.3171	-0.0055	0.9821***	0.9762
EPP	-0.1028***	0.6567***	0.3124	-0.018***	0.9962***	0.9826
EWA	-0.1065***	0.6522***	0.3449	-0.02***	0.997***	0.9827
EWH	-0.0941***	0.6704***	0.3056	-0.0144***	0.9984***	0.9898
EWJ	-0.165***	0.4018***	0.1644	-0.0087***	0.996***	0.9973
EWM	-0.0921***	0.7373***	0.2854	-0.026**	1.0038***	0.7783
EWS	-0.0687**	0.7939	0.4367	-0.0177***	0.9945***	0.9833
EWT	-0.094***	0.6812***	0.3148	-0.0137**	1.0006***	0.9685
EWY	-0.096***	0.6484***	0.3417	-0.0078***	0.9953***	0.9981
FXI	-0.1071**	0.6564***	0.3056	-0.0148*	0.9871***	0.9664
HEWJ	-0.0114	0.5916***	0.3128	-0.0078	0.5811***	0.3024
INDA	-0.0157	0.8515***	0.5116	-0.0055	0.9898***	0.9884
INDY	-0.0215	0.8018***	0.4164	-0.0087	0.9681***	0.9260
IPAC	-0.0261	0.428***	0.1948	-0.0101**	1.002***	0.9888
JPMV	-0.0221	0.3995***	0.2064	-0.0085*	0.9972***	0.9897
JPXN	-0.0157	0.4797***	0.3415	-0.0229	0.7763***	0.7789
MCHI	-0.0186	0.6907***	0.3826	-0.0116***	0.9995***	0.9909
SCJ	-0.0561*	0.3878***	0.1319	-0.0102***	0.9957***	0.9914
SMIN	-0.0092	0.8495***	0.4901	-0.0068**	1.0161***	0.9948
THD	-0.0192	0.8338***	0.4563	-0.0124**	0.9909***	0.9767

Panel B: Results for International ETFs tracking European Indices

	Dependent variable: $(R_{ETF} - R_{rf})$			**Dependent variable**: $(R_{NAV} - R_{rf})$		
	α	β_1	$Adj. R^2$	α	β_1	$Adj. R^2$
EDEN	0.0017	0.8279***	0.6542	-0.0059***	0.9982***	0.9951
EFNL	-0.0173	0.8049***	0.6093	-0.0107*	1.0002***	0.9763
EIRL	-0.012	0.8582***	0.6364	-0.0089***	0.9812***	0.9916
EIS	-0.0235	0.8159***	0.4606	-0.0121**	0.9883***	0.9661
ENOR	-0.0218	0.8029***	0.6305	-0.0125***	1.001***	0.9883
EPOL	-0.0166	0.8812***	0.6160	-0.0176***	0.9808***	0.9724
ERUS	-0.02	0.8426***	0.5608	-0.0176**	0.9733***	0.9760
EUFN	-0.0164	0.9122***	0.7625	-0.0126***	0.9966***	0.9920
EUMV	-0.026	0.8234***	0.6841	-0.011**	0.9961***	0.9823
EWD	-0.0526*	0.8471***	0.6227	-0.0131***	1.0002***	0.9893
EWG	-0.0447**	0.8631***	0.6687	-0.0109***	0.9957***	0.9925
EWGS	-0.0081	0.8579***	0.7237	-0.0056*	0.9986***	0.9916
EWI	-0.0551**	0.855***	0.6666	-0.0161***	0.9888***	0.9909
EWK	-0.0643***	0.811***	0.5821	-0.0241***	0.9628***	0.9481
EWL	-0.0516***	0.8196***	0.5890	-0.01***	0.9862***	0.9890
EWN	-0.0504**	0.851***	0.6265	-0.0132***	0.995***	0.9912
EWO	-0.0526**	0.845***	0.6541	-0.0148***	0.9773***	0.9926
EWP	-0.0612**	0.8425***	0.6469	-0.0269***	0.9701***	0.9827

EWQ	-0.0566**	0.8309***	0.6331	-0.0122***	0.9971***	0.9921
EWU	-0.0671***	0.8127***	0.5879	-0.0183***	0.9966***	0.9869
EWUS	-0.0157	0.913	0.7713	-0.0136***	0.9964***	0.9884
EZU	-0.0531**	0.8485***	0.6193	-0.0132***	0.9968***	0.9913
HEWG	-0.0178	0.8572***	0.7254	-0.0158	0.8475***	0.7216
HEZU	-0.0177	0.8481***	0.7063	-0.0154	0.8497***	0.6991
IEUR	-0.0191	0.828***	0.6640	-0.0091*	0.9963***	0.9875
IEUS	-0.0142	0.8656***	0.6550	-0.0063	0.9901***	0.9875
IEV	-0.0572**	0.8365***	0.6135	-0.0166***	0.9901***	0.9783
TUR	-0.0189	0.8794***	0.5750	-0.0089***	0.9988***	0.9962

In addition, we find that the β_1 coefficients of almost all international ETFs (with a couple of exceptions) are statistically different from one. These findings imply that most of the ETFs samples depart from the full-replication strategy. In that case, it is imperative to understand the magnitude of the deviation of β_1 from unity. For the Asia-Pacific group of ETFs, our findings show that β_1 of the CAPM model based on the trading price returns, vary from 0.3995 to 0.8495 and their average deviation from unity is 32.60 bps which is not only statistically but also economically significant. On the contrary, the β_1 of the CAPM model based on the NAV returns, vary from 0.5811 to 1.0682 and their average deviation from unity is 2.65 bps which is significant statistical but insignificant in the economic sense. For European group of ETFs, when we estimate the CAPM model based on the trading price returns, the result shows that the β_1 coefficient ranges between 0.8029 and 0.9130 and the average deviation from unity is 15.42 bps, which is not only statistically but also economically significant. On the other hand, when we estimate the CAPM model based on the NAV returns, we note that the β_1 coefficient varies from 0.5811 to 1.0682 and their average deviation from unity is 1.97 bps which is statistically significant but insignificant in the economic sense.

Overall, the results for the Asia-Pacific and the European group of ETFs are consistent, in a way that in both cases the deviation of β_1 from unity is higher when estimated by the CAPM model based on the trading price returns compared to the NAV returns. Therefore, we can conclude that NAV return is more appropriate performance indicator of international ETFs than the trading price return. This is because the trading prices of international ETFs do not reflect all available information relative to NAV.

5.6 Tracking inefficiency of International ETFs

5.6.1 Measuring the tracking error

Table 5-12 presents the tracking errors of international ETFs offering exposure of the Asia-Pacific and the European markets in Panel A and B, respectively. For each panel, we first estimate ETF return in both trading price and NAV term, then for each return type, we estimate the tracking error with two methods: (1) the absolute difference in ETF and its benchmark returns and (2) the standard deviation of the difference in ETF and its benchmark returns. The average tracking errors of both methods, using ETF returns based on trading prices and NAVs, are reported Table 10.

Table 5-12: Tracking errors of International ETFs

Table 5-12 reports the tracking errors measured in trading price and NAV of the international ETFs using the two methods (1) the absolute return differential and (2) the standard deviation of the return differential.

Panel A: Tracking errors of International ETFs tracking Asia-Pacific Indices

	Tracking error between R_{ETF} and R_{Ind}			Tracking error between R_{NAV} and R_{Ind}		
	$TE_{ETF,1}$	$TE_{ETF,2}$	$\overline{TE}_{ETF}$	$TE_{NAV,1}$	$TE_{NAV,2}$	$\overline{TE}_{NAV}$
AAXJ	1.0106	1.2031	1.1069	0.2218	0.2605	0.2412
AIA	0.9561	1.1612	1.0587	0.0700	0.0877	0.0789
AXJV	0.5133	0.9005	0.7069	0.0562	0.3113	0.1838
DVYA	0.6192	0.7318	0.6755	0.0302	0.0388	0.0345
ECNS	0.8831	1.0633	0.9732	0.0703	0.0854	0.0778
EEMA	0.7186	0.8511	0.7849	0.0193	0.0242	0.0217
EIDO	1.0697	1.2612	1.1654	0.0199	0.0241	0.0220
ENZL	0.5456	0.6483	0.5969	0.0304	0.0410	0.0357
EPHE	0.9025	1.0659	0.9842	0.0337	0.0419	0.0378
EPP	1.0259	1.2501	1.1380	0.0293	0.0385	0.0339
EWA	1.1317	1.3846	1.2582	0.0348	0.0458	0.0403
EWH	0.9905	1.1906	1.0905	0.0338	0.0432	0.0385
EWJ	1.1127	1.3474	1.2301	0.0379	0.0471	0.0425
EWM	0.9353	1.1216	1.0285	0.0519	0.0681	0.0600
EWS	0.8574	1.0379	0.9476	0.0476	0.0603	0.0539
EWT	1.0570	1.2689	1.1629	0.0400	0.0516	0.0458
EWY	1.2191	1.4613	1.3402	0.0256	0.0295	0.0276
FXI	1.4012	1.7008	1.5510	0.0498	0.0627	0.0562
HEWJ	1.0594	1.2874	1.1734	1.0660	1.2951	1.1805
INDA	0.7790	0.9372	0.8581	0.0270	0.0342	0.0306
INDY	0.9324	1.1259	1.0291	0.2000	0.2490	0.2245
IPAC	0.8382	1.0101	0.9241	0.0290	0.0340	0.0315
JPMV	0.8403	1.0278	0.9340	0.0191	0.0240	0.0216
JPXN	0.9515	1.0976	1.0245	0.5029	0.5293	0.5161
MCHI	0.8818	1.0479	0.9649	0.0199	0.0265	0.0232
SCJ	0.9740	1.1563	1.0652	0.0278	0.0335	0.0306
SMIN	0.8603	1.0298	0.9451	0.0399	0.0444	0.0421
THD	0.8900	1.0530	0.9715	0.0599	0.0718	0.0659
Mean	**0.9270**	**1.1222**	**1.0246**	**0.1034**	**0.1323**	**0.1178**

Panel B: Tracking errors of International ETFs tracking European Indices

	Tracking error between R_{ETF} and R_{Ind}			Tracking error between R_{NAV} and R_{Ind}		
	$TE_{ETF,1}$	$TE_{ETF,2}$	$\overline{TE}_{ETF}$	$TE_{NAV,1}$	$TE_{NAV,2}$	$\overline{TE}_{NAV}$
EDEN	0.4934	0.6042	0.5488	0.0191	0.0228	0.0209
EFNL	0.5713	0.7017	0.6365	0.0255	0.0350	0.0302
EIRL	0.5947	0.7328	0.6638	0.0630	0.0733	0.0681
EIS	0.6538	0.7850	0.7194	0.0328	0.0422	0.0375
ENOR	0.6727	0.8336	0.7532	0.0264	0.0352	0.0308
EPOL	0.8306	1.0276	0.9291	0.0494	0.0580	0.0537
ERUS	1.0037	1.2236	1.1137	0.0874	0.1061	0.0967
EUFN	0.6317	0.7783	0.7050	0.0316	0.0400	0.0358

EUMV	0.4149	0.5157	0.4653	0.0281	0.0361	0.0321
EWD	0.8403	1.0363	0.9383	0.0286	0.0364	0.0325
EWG	0.6931	0.8559	0.7745	0.0300	0.0379	0.0339
EWGS	0.4326	0.5297	0.4811	0.0210	0.0252	0.0231
EWI	0.8108	1.0039	0.9073	0.0644	0.0749	0.0696
EWK	0.7153	0.8786	0.7970	0.0987	0.1118	0.1052
EWL	0.5956	0.7280	0.6618	0.0452	0.0501	0.0476
EWN	0.6897	0.8566	0.7731	0.0398	0.0493	0.0445
EWO	0.7690	0.9492	0.8591	0.0615	0.0693	0.0654
EWP	0.8122	0.9993	0.9057	0.0822	0.0914	0.0868
EWQ	0.7345	0.9171	0.8258	0.0297	0.0393	0.0345
EWU	0.6833	0.8359	0.7596	0.0353	0.0460	0.0406
EWUS	0.4707	0.5854	0.5281	0.0213	0.0281	0.0247
EZU	0.7375	0.9150	0.8262	0.0269	0.0343	0.0306
HEWG	0.4888	0.6140	0.5514	0.4861	0.6066	0.5464
HEZU	0.5165	0.6396	0.5780	0.5300	0.6559	0.5930
IEUR	0.5118	0.6387	0.5752	0.0212	0.0274	0.0243
IEUS	0.5249	0.6450	0.5850	0.0313	0.0370	0.0341
IEV	0.6629	0.8172	0.7401	0.1023	0.1277	0.1150
TUR	0.9034	1.1024	1.0029	0.0203	0.0255	0.0229
Mean	**0.6593**	**0.8125**	**0.7359**	**0.0764**	**0.0937**	**0.0850**

For the Asia-Pacific group of ETFs, the average tracking errors based on trading prices return ($\overline{\boldsymbol{TE}}_{\boldsymbol{ETF}}$) varies from 0.5969 to 1.5510% whereas the average tracking errors based on NAV return ($\overline{\boldsymbol{TE}}_{\boldsymbol{NAV}}$) ranges between 0.0216 to 1.1805%. However, in the case of the European group of ETFs, the average tracking errors based on trading prices return ($\overline{\boldsymbol{TE}}_{\boldsymbol{ETF}}$) varies from 0.4653 to 1.1137% whereas the average tracking errors based on NAV return ($\overline{\boldsymbol{TE}}_{\boldsymbol{NAV}}$) ranges between 0.0209 to 0.5930%. In both the Asia-Pacific and the European group of ETFs, we note that the average tracking errors based on NAV returns are lower than the average tracking errors based on trading prices return, which implies that NAV is more efficient in tracking the performance of underlying indices than the trading prices. The tracking errors in terms of trading price returns are inflated, which indicates that the trading price as unreliable ETF's performance measure relative to the NAV.

By comparing the group averages of tracking errors estimated in trading price returns and NAV returns, we find that the European group of ETFs are superior in tracking efficiency compared to the Asia-Pacific group of ETFs. For the European group of ETFs, the group averages in terms of trading price returns and NAV returns are 0.7359% and 0.0850%, which are significantly lower than the group averages of ETFs tracking the Asia-Pacific ETFs of 1.0246% and 0.1178%, respectively. Our findings, on the superiority of the European markets over the Asia-Pacific markets with respect to the tracking efficiency of US-listed international ETFs, is consistent with the results of Shin and Soydemir (2010).

5.6.2 Persistence of tracking error

Table 5-13 reports the results for the persistence of tracking errors in international ETFs tracking the Asia-Pacific and the European markets in Panel A and B, respectively. Each panel contains the findings estimated by model (19) and (20) using the second-order autocorrelation AR (2) estimator and regressing the tracking errors on the values of their two lagged days. The results include both the trading price and NAV based tracking errors for each group (the Asia-Pacific and the European) of ETFs.

The $alpha$ (α) coefficient, which is the constant term in model (19) and (20), indicates the constant portion of tracking errors remain unexplained by their lagged values. We note that all $alpha$ (α) coefficients, irrespective of the underlying markets and the types of tracking errors (i.e. $TE1_{ETF,1}$ and $TE1_{NAV,1}$), are statistically significant. These results imply that a significant portion of tracking errors remain unexplained by their lagged values.

Table 5-13: Regression results for the persistence of tracking errors

Table 5-13 reports the results of model (19): $TE1_{ETF,t} = \alpha + \beta_1 TE1_{ETF,t-1} + \beta_2 TE1_{ETF,t-2} + \varepsilon_t$ and model (20): $TE1_{NAV,t} = \alpha + \beta_1 TE1_{NAV,t-1} + \beta_2 TE1_{NAV,t-2} + \varepsilon_t$. Panel A (Panel B) reports the results of ETFs tracking the Asia-Pacific (European) markets. The standard errors for the estimated coefficients, are heteroscedasticity and autocorrelation consistent standard errors (Newey & West, 1986) that are not reported here for the sake of brevity. "***", "**", and "*", represents the significance at 1%, 5%, and 10% level, respectively.

Panel A: Results for International ETFs tracking Asia-Pacific Indices

	$\boldsymbol{Dependent\ variable}$: $\boldsymbol{TE_{ETF,1}}$				$\boldsymbol{Dependent\ variable}$: $\boldsymbol{TE_{NAV,1}}$			
	$\boldsymbol{\alpha}$	$\boldsymbol{\beta_1}$	$\boldsymbol{\beta_2}$	$\boldsymbol{R^2}$	$\boldsymbol{\alpha}$	$\boldsymbol{\beta_1}$	$\boldsymbol{\beta_2}$	$\boldsymbol{R^2}$
AAXJ	0.4202***	0.4204***	0.1644***	0.2728	0.0663***	0.4893***	0.2106***	0.4110
AIA	0.419***	0.4159***	0.1453***	0.2520	0.0515***	0.1074***	0.1573***	0.0394
AXJV	0.4643***	0.1261	-0.0216	0.0008	0.0453***	0.0691	0.1241	0.0067
DVYA	0.4021***	0.3269***	0.0212	0.1096	0.0298***	-0.0055	0.0188	-0.0028
ECNS	0.5215***	0.3478***	0.0597*	0.1385	0.0296***	0.3663***	0.1866***	0.2404
EEMA	0.5299***	0.264***	-0.0004	0.0680	0.0197***	-0.0098	-0.0104	-0.0016
EIDO	0.7115***	0.2798***	0.0544**	0.0892	0.019***	0.0413	-0.0016	0.0004
ENZL	0.4292***	0.2628***	-0.0485	0.0568	0.0311*	-0.0106	-0.007	-0.0087
EPHE	0.5588***	0.2755***	0.1052***	0.1036	0.0106***	0.2227***	0.3631***	0.3693
EPP	0.3808***	0.4678***	0.1606***	0.3278	0.0272***	0.0844***	-0.0134	0.0062
EWA	0.424***	0.4827***	0.1423***	0.3299	0.0352***	-0.0049	-0.0052	-0.0008
EWH	0.3898***	0.4752***	0.1304***	0.3100	0.033***	0.0290	-0.005	0.0000
EWJ	0.4694***	0.4109***	0.1672***	0.2638	0.0377***	0.0127	-0.0053	-0.0007
EWM	0.6044***	0.2492***	0.1042***	0.0866	0.0514***	0.0036	0.0058	-0.0008
EWS	0.3783***	0.4469***	0.1116***	0.2617	0.0481***	-0.0016	-0.0078	-0.0008
EWT	0.5201***	0.3434***	0.1647***	0.1907	0.0366***	0.1029***	-0.0157	0.0096
EWY	0.5387***	0.4636***	0.0942***	0.2678	0.0247***	0.0181	0.0161	-0.0003
FXI	0.5861***	0.4306***	0.1494***	0.2728	0.0343***	0.5657***	-0.2534***	0.2542
HEWJ	0.6666***	0.3352***	0.0371	0.1185	0.6728***	0.3508***	0.0199	0.1245
INDA	0.5661***	0.2724***	0.0021	0.0730	0.0101***	0.5223***	0.0469*	0.3203
INDY	0.5418***	0.2953***	0.1217***	0.1258	0.095***	0.5234***	-0.0089	0.2823
IPAC	0.5281***	0.3064***	0.0651	0.1074	0.0304***	-0.0182	-0.0244	-0.0032
JPMV	0.511***	0.3328***	0.0610	0.1250	0.0194***	-0.0094	-0.0033	-0.0043
JPXN	0.6831***	0.2644***	0.0185	0.0683	0.4695***	0.0337	0.0328	-0.0026
MCHI	0.5575***	0.3606***	0.0075	0.1306	0.0183***	0.0922***	-0.0106	0.0068

SCJ	0.5476***	0.3577***	0.0767***	0.1548	0.026***	0.0344	0.0257	0.0004
SMIN	0.575***	0.3064***	0.0261	0.0978	0.0284***	0.1238***	0.1628***	0.0459
THD	0.4902***	0.2871***	0.1606***	0.1392	0.0352***	0.2055***	0.2065***	0.1059

Panel B: Results for International ETFs tracking European Indices

	$\boldsymbol{Dependent\ variable}: \boldsymbol{TE_{ETF,1}}$				$\boldsymbol{Dependent\ variable}: \boldsymbol{TE_{NAV,1}}$			
	$\boldsymbol{\alpha}$	$\boldsymbol{\beta_1}$	$\boldsymbol{\beta_2}$	$\boldsymbol{R^2}$	$\boldsymbol{\alpha}$	$\boldsymbol{\beta_1}$	$\boldsymbol{\beta_2}$	$\boldsymbol{R^2}$
EDEN	0.3543***	0.3187***	-0.0364	0.0942	0.0182***	0.0206	0.02	-0.0009
EFNL	0.367***	0.4216***	-0.0633**	0.1591	0.0257***	-0.0059	-0.0012	-0.0018
EIRL	0.3573***	0.3508***	0.0474	0.1359	0.0577***	0.0525*	0.0316	0.0022
EIS	0.3805***	0.2675***	0.1482***	0.1179	0.0272***	0.1377***	0.0329	0.0202
ENOR	0.4755***	0.3557***	-0.0651**	0.1137	0.0268***	-0.0018	-0.0096	-0.0017
EPOL	0.5135***	0.3549***	0.0260	0.1322	0.0286***	0.2117***	0.2099***	0.1116
ERUS	0.5746***	0.4054***	0.0216	0.1708	0.0503***	0.2448***	0.1577***	0.1122
EUFN	0.3247***	0.4344***	0.05**	0.2105	0.0315***	-0.0028	0.0041	-0.0012
EUMV	0.2451***	0.3579***	0.0520	0.1411	0.0278***	-0.0046	0.0158	-0.0040
EWD	0.3733***	0.465***	0.0911***	0.2671	0.0287***	-0.0027	-0.0023	-0.0009
EWG	0.3143***	0.5115***	0.0351*	0.2812	0.0291***	0.0166	0.0136	-0.0004
EWGS	0.2959***	0.3163***	-0.0003	0.0982	0.021***	-0.0018	0.0001	-0.0019
EWI	0.3952***	0.4915***	0.0213	0.2519	0.0571***	0.0634***	0.0508**	0.0062
EWK	0.337***	0.3445***	0.1847***	0.2058	0.0887***	0.0603***	0.0407*	0.0046
EWL	0.2626***	0.3866***	0.1727***	0.2409	0.0419***	0.0352*	0.035*	0.0017
EWN	0.3205***	0.4425***	0.0931***	0.2440	0.0367***	0.0447**	0.0305	0.0021
EWO	0.3838***	0.4853***	0.0159	0.2427	0.0534***	0.0702***	0.0611***	0.0084
EWP	0.3858***	0.4809***	0.0443**	0.2540	0.0739***	0.0565***	0.0444**	0.0046
EWQ	0.3484***	0.4974***	0.0286	0.2621	0.0287***	0.0142	0.0189	-0.0003
EWU	0.2681***	0.4994***	0.1085***	0.3213	0.0359***	-0.0078	-0.0101	-0.0007
EWUS	0.3245***	0.347***	-0.0353	0.1113	0.0218***	-0.0118	-0.008	-0.0020
EZU	0.3408***	0.488***	0.0502**	0.2652	0.0269***	-0.0014	-0.0001	-0.0009
HEWG	0.2644***	0.482***	-0.0214	0.2197	0.265***	0.4632***	-0.0071	0.2082
HEZU	0.2987***	0.445***	-0.0208	0.1867	0.3179***	0.4539***	-0.0531	0.1842
IEUR	0.318***	0.3723***	0.0090	0.1380	0.0213***	-0.0055	0.0032	-0.0040
IEUS	0.3425***	0.3401***	0.0048	0.1138	0.0246***	0.0912**	0.0798**	0.0136
IEV	0.2751***	0.4999***	0.0855***	0.3034	0.0656***	0.2217***	0.137***	0.0827
TUR	0.5143***	0.3836***	0.0463**	0.1628	0.0184***	0.0821***	0.0067	0.0058

In terms of the impact of past values of the tracking errors on their present values, the coefficients β_1 and β_2 represent the magnitudes of the impact of past values of the tracking errors on their present values. The results of model (19) based on the *trading price tracking errors* show that the β_1 coefficients are positive and significant for almost all international ETFs with an exception of one ETF in the Asia-Pacific group. The β_2 coefficients are positive and significant for 17 out of 28 ETFs of the Asia-Pacific group and 12 out of 28 ETFs of the European group. These results imply that the tracking errors persist in almost all ETFs for one day but diminishes in most of the ETFs after two days. In addition, we also note that the β_2 coefficients are negative and statistically significant for two ETFs of the European group, indicating their mean-reverting behaviour. This means the *trading price tracking errors* of these ETFs tend to move to their mean values.

The results of model (20) based on the *NAV tracking errors* show that the β_1 coefficients are positive and significant for 13 out of 28 ETFs of the Asia-Pacific group and 15 out of 28 ETFs of the European group. The β_2 coefficients are positive and significant for 7 out of 28 ETFs of the Asia-Pacific group and 9 out of 28 ETFs of the European group. The results suggest that the *NAV tracking errors* persist in almost half of the ETFs of each group (i.e. the Asia-Pacific and the European) for one day but after two days *NAV tracking errors* persist in only a few ETFs. Further, the negative and significant β_2 coefficients for one ETF of the Asia-Pacific group suggest its tendency to approach the mean values of the NAV tracking errors.

Based on our findings, we conclude that tracking errors persist for more number of international ETFs when estimated in terms of trading price. In other words, NAV tracking errors more quickly diminish over the time compared to the trading price tracking errors.

5.7 Pricing inefficiency of International ETFs

5.7.1 Measuring the premium/discount

In this section, we present the results related to the pricing efficiency of international ETFs tracking the Asia-Pacific and the European markets in Panel A and B, respectively. Each panel reports both the percentage estimates and the OLS regression estimates of pricing efficiency of international ETFs.

According to the percentage estimates of the Asia-Pacific group of ETFs, there are 9 ETFs traded at the average discount of -9.15 bps while 19 trade at the average premium of 9.15 bps. However, in the case of the European group of ETFs, only 3 ETFs traded at the average discount of -4.2 bps while the remaining 25 ETFs traded at the average premium of 12.04 bps. Based on these results, we can infer that most of the ETFs from the Asia-Pacific (i.e. 19 out of 28) and the European (i.e. 25 out of 28) groups trade at a premium.

Table 5-14: Premium/discount of International ETFs

Table 5-14 reports the percentage premium and the estimates of model (22): $CP_{ETF,t} = \alpha + \beta_1 CP_{NAV,t} + \varepsilon_t$. Panel A (Panel B) reports the results of ETFs tracking the Asia-Pacific (European) markets. For model (22), the standard errors for the estimates are heteroscedasticity and autocorrelation consistent standard errors (Newey & West, 1986) that are not reported here for the sake of brevity. "***", "**", and "*", represents the significance at 1%, 5%, and 10% level, respectively.

Panel A: Results for International ETFs tracking Asia-Pacific Indices

	$\boldsymbol{Premium}$ (%)	$\boldsymbol{\alpha}$	$\boldsymbol{\beta_1}$	$\boldsymbol{R^2}$	$\boldsymbol{Premium = \beta_1 - 1}$

AAXJ	0.0989	0.3147***	0.9951***	0.9964	-0.0049
AIA	0.0016	-0.1923	1.0043***	0.9867	0.0043
AXJV	0.0212	-0.1502	1.0034***	0.9966	0.0034
DVYA	0.0130	-0.5237***	1.0115***	0.9979	0.0115
ECNS	-0.2817	-0.8732***	1.0169***	0.9943	0.0169
EEMA	0.0985	-1.8571***	1.0348***	0.9892	0.0348
EIDO	-0.1358	0.0065	0.9984***	0.9885	-0.0016
ENZL	0.0773	0.1782	0.9965***	0.9951	-0.0035
EPHE	-0.1326	0.1339**	0.9945***	0.9956	-0.0055
EPP	0.0209	-0.095	1.0024***	0.9933	0.0024
EWA	0.0413	-0.0221	1.0014***	0.9947	0.0014
EWH	-0.0038	-0.0269	1.0014***	0.9948	0.0014
EWJ	0.0119	0.0613	0.9988***	0.9929	-0.0012
EWM	-0.0442	-0.0416	1.0004***	0.9979	0.0004
EWS	-0.0102	-0.0379	1.0015***	0.9950	0.0015
EWT	-0.0718	-0.1047**	1.0031***	0.9926	0.0031
EWY	-0.1400	-0.2251**	1.0027***	0.9924	0.0027
FXI	0.0163	0.0158	0.9997***	0.9911	-0.0003
HEWJ	-0.0036	0.0049	0.9998***	0.9999	-0.0002
INDA	0.2417	-0.213***	1.0104***	0.9942	0.0104
INDY	0.1877	-0.2677***	1.0122***	0.9943	0.0122
IPAC	0.1365	-0.7449**	1.0167***	0.9735	0.0167
JPMV	0.0580	1.7255***	0.9704***	0.9522	-0.0296
JPXN	0.2077	-0.9317	1.0199***	0.9554	0.0199
MCHI	0.0816	-0.2448**	1.0062***	0.9923	0.0062
SCJ	0.0685	-0.0025	1.0008***	0.9942	0.0008
SMIN	0.3135	0.0966*	0.9996***	0.9962	-0.0004
THD	0.0425	0.0635	0.9995***	0.9972	-0.0005

Panel B: Results for International ETFs tracking European Indices

	$\boldsymbol{Premium}$ (%)	$\boldsymbol{\alpha}$	$\boldsymbol{\beta_1}$	$\boldsymbol{R^2}$	$\boldsymbol{Premium = \beta_1 - 1}$
EDEN	0.1364	0.1395***	0.9982***	0.9994	-0.0018
EFNL	0.1292	0.0639	0.9992***	0.9973	-0.0008
EIRL	0.6248	0.1068***	1.0028***	0.9987	0.0028
EIS	-0.0610	-0.2355***	1.0043***	0.9958	0.0043
ENOR	0.0817	-0.082***	1.0041***	0.9986	0.0041
EPOL	0.0753	-0.0128	1.0013***	0.9982	0.0013
ERUS	0.1057	-0.0496	1.0024***	0.9986	0.0024
EUFN	0.1612	0.0199	1.0006***	0.9984	0.0006
EUMV	0.1579	-0.4428***	1.0206***	0.9909	0.0206
EWD	0.0179	-0.0023	1.0003***	0.9975	0.0003
EWG	0.0502	0.0311	0.9993***	0.9984	-0.0007
EWGS	0.0635	0.2192***	0.9949***	0.9983	-0.0051
EWI	0.0550	0.0372**	0.9994***	0.9996	-0.0006
EWK	0.0209	-0.0119	1.001***	0.9994	0.0010
EWL	0.0568	0.0207	0.9998***	0.9988	-0.0002
EWN	0.0273	0.0027	1.0002***	0.9985	0.0002
EWO	-0.0656	0.0034	0.9992***	0.9995	-0.0008
EWP	0.0282	0.0302	0.9995***	0.9991	-0.0005
EWQ	0.0622	0.0415**	0.999***	0.9986	-0.0010
EWU	0.2465	-0.035	1.0034***	0.9981	0.0034
EWUS	0.2065	0.3999***	0.9914***	0.9967	-0.0086
EZU	0.0660	0.0174	1.0002***	0.9990	0.0002
HEWG	-0.0004	-0.0777***	1.0032***	0.9999	0.0032
HEZU	0.0026	-0.0374	1.0015***	0.9996	0.0015
IEUR	0.2417	-0.1742	1.0065***	0.9945	0.0065
IEUS	0.2895	-1.9361***	1.0467***	0.9833	0.0467
IEV	0.0636	-0.0119	1.0009***	0.9985	0.0009
TUR	0.0384	-0.1976***	1.0043***	0.9977	0.0043

With regard to the OLS regression estimates, the $alpha$ (α) coefficient in the model (22) represents the constant part that may affect the trading prices other than the NAV. According to our results, the $alpha$ (α) coefficients are statistically significant for thirteen (13) ETFs of the Asia-Pacific group and twelve (12) ETFs of the European group but for a majority of the ETFs sample, the $alpha$ (α) coefficients are insignificant. In addition, the β_1 coefficients is the magnitude of the contribution of NAV to the trading price of international ETFs. If ETFs are efficiently priced or there is no deviation between NAV and trading price, we expect β_1 coefficient to be equal to one. Our findings suggest that the β_1 coefficients for all international ETFs are positively significant, regardless of the markets they track. Coincidently, we find 10 ETFs from each group (i.e. the Asia-Pacific and the European) trade at discount to their NAV and 18 ETFs trade at a premium to their NAV.

Overall, the findings of the percentage estimates and the OLS regression estimates of pricing efficiency of international ETFs are consistent. We provide evidence in favour of pricing inefficiency of international ETFs, irrespective of the market they track. They mainly traded at a premium.

5.7.2 Persistence of premium/discount

Table 5-15 reports the results for the persistence of premium or discount in international ETFs tracking the Asia-Pacific and European markets in Panel A and B, respectively. Each panel contains the findings estimated by model (23) using the second-order autocorrelation AR (2) estimator and regressing the $Premium_t$ on their lagged values of two days.

Table 5-15: Regression results for the persistence of premium/discount

Table 5-15 reports the estimates of model (23): $Premium_t = \alpha + \beta_1 Premium_{t-1} + \beta_2 Premium_{t-2} + \varepsilon_t$. Panel A (Panel B) presents the results of ETFs tracking the Asia-Pacific (European) markets. The standard errors for the estimates are heteroscedasticity and autocorrelation consistent standard errors (Newey & West, 1986) that are not reported here for the sake of brevity. "***", "**", and "*", represents the significance at 1%, 5%, and 10% level, respectively.

Panel A: Results of International ETFs tracking Asia-Pacific Indices

	$\boldsymbol{\alpha}$	$\boldsymbol{\beta_1}$	$\boldsymbol{\beta_2}$	$\boldsymbol{R^2}$
AAXJ	0.0657***	0.2332***	0.0997***	0.0755
AIA	0.0009	0.1389***	0.0950***	0.0311
AXJV	0.0100	0.3293***	0.1260	0.1416
DVYA	0.0084	0.1776***	0.0966**	0.0446
ECNS	-0.1306***	0.3402***	0.2004***	0.2124
EEMA	0.0458*	0.3450***	0.1818***	0.2033
EIDO	-0.0620*	0.4233***	0.1221***	0.2429
ENZL	0.0730**	0.1028	-0.0431	0.0026
EPHE	-0.0698***	0.3612***	0.1096***	0.1734
EPP	0.0204	0.0448**	-0.0060	0.0011

EWA	0.0432*	-0.0266	-0.0131	0.0000
EWH	-0.0027	0.0770***	0.0022	0.0051
EWJ	0.0117	0.0894***	-0.0253	0.0074
EWM	-0.0323	0.2097***	0.0523**	0.0507
EWS	-0.0095	0.0979***	-0.0082	0.0086
EWT	-0.0570**	0.1932***	0.0167	0.0380
EWY	-0.1246***	0.0989***	0.0113	0.0093
FXI	0.0180	0.0673***	-0.0768***	0.0089
HEWJ	-0.0037	0.1289***	0.0746	0.0211
INDA	0.1490***	0.2563***	0.1193***	0.0965
INDY	0.1282***	0.2075***	0.1060***	0.0633
IPAC	0.1032**	0.1332***	0.0930**	0.0260
JPMV	0.0488	0.0919**	0.0879*	0.0135
JPXN	0.1444***	0.1960***	0.1114**	0.0557
MCHI	0.0563**	0.2318***	0.0605**	0.0627
SCJ	0.0456	0.2056***	0.0735***	0.0532
SMIN	0.0965***	0.4133***	0.2743***	0.3741
THD	0.0274	0.2222***	0.0913***	0.0667

Panel B: Results of International ETFs tracking European Indices

	α	β_1	β_2	R^2
EDEN	0.1031***	0.1225***	0.1176***	0.0311
EFNL	0.1160***	0.0407	0.0560*	0.0032
EIRL	0.1797***	0.3660***	0.3419***	0.3897
EIS	-0.0457**	0.2170***	0.0522**	0.0539
ENOR	0.0720***	0.0452	0.0702**	0.0055
EPOL	0.0714***	0.0299	0.0449*	0.0017
ERUS	0.0965***	0.0679**	-0.0059	0.0032
EUFN	0.1288***	0.0722***	0.1340***	0.0237
EUMV	0.1121***	0.1549***	0.1444***	0.0487
EWD	0.0187	-0.0514**	0.0068	0.0018
EWG	0.0575***	-0.1136***	-0.0315	0.0122
EWGS	0.0436***	0.1639***	0.1506***	0.0571
EWI	0.0580***	-0.0815***	0.0223	0.0066
EWK	0.0180	0.0517**	0.0743***	0.0076
EWL	0.0583***	0.0020	-0.0350*	0.0003
EWN	0.0267	-0.0001	0.0136	-0.0007
EWO	-0.0550***	0.0697***	0.0981***	0.0146
EWP	0.0299*	-0.0913***	0.0312	0.0090
EWQ	0.0681***	-0.1067***	0.0125	0.0109
EWU	0.2221***	0.0007	0.0947***	0.0081
EWUS	0.0812***	0.2918***	0.3070***	0.2515
EZU	0.0710***	-0.100***	0.0167	0.0097
HEWG	-0.0008	0.1593***	0.2057***	0.0784
HEZU	0.0022	0.0246	-0.0093	-0.0039
IEUR	0.2178***	0.0188	0.0774*	0.0024
IEUS	0.1325***	0.2849***	0.2628***	0.2063
IEV	0.0667***	-0.0962***	0.0409*	0.0108
TUR	0.0319	0.0984***	0.0377	0.0108

The $alpha$ (α) coefficients in model (23) exogenously affect the premium or discount of international ETFs. Although, we note that $alpha$ (α) coefficients for 15 ETFs from the Asia-Pacific and 22 ETFs from the European group are statistically significant. However, economically, most of $alpha$ (α) coefficients are under 10 bps and have no material contribution in the premium or discount of ETFs. These results imply that intrinsic frictions in the pricing induce the deviation between the trade prices and NAVs of international ETFs.

As far as the pricing inefficiency is concerned, our results suggest that premium or discount slightly fade away as they move from one to two days lag despite a majority of international ETFs in the sample persist for two days. More specifically, the premium or discount persists in 26 ETFs in the Asia-Pacific and 20 ETFs in the European group for one day. However, the persistence effect slightly diminishes for two days, as the number of ETFs which suffers from pricing inefficiency reduces to 18 ETFs in each of the two groups (i.e. the Asia-Pacific and the European). Therefore, based on our findings, we conclude that there exist significant arbitrage opportunities in international ETFs which remain available for two days in most of the cases.

5.8 Conclusion

This chapter presented and discussed the results of various aspects of market efficiency and performance dynamics of international ETFs. As long as the results related to the market efficiency of international ETFs are concerned, the study found that the returns of International ETFs do not follow *random walk* and can be predicted through technical analysis and hence invalidate the EMH. On examination of *calendar anomalies*, the study observe a time-varying “Monday effect” and “January effect” in the returns of international ETFs which shows that market efficiency evolves over time and thus consistent with AMH.

With regard to performance dynamics of international ETFs, we found that (1) the *trading price returns* performs well for ETFs tracking the Asia-Pacific market while *NAV returns* are superior in the case of the European group of ETFs, (2) *trading price return volatilities* are higher than the *NAV return volatilities* in both the Asia-Pacific and the European group of international ETFs, (3) *overnight returns and return volatilities* both are higher than the *intraday returns and return volatilities*, (4) the results of risk-adjusted performance reveal that NAV returns are better performance indicator of international ETFs than the trading price return, (5) the *NAV tracking errors* are lower than the *trading price tracking errors* for both the Asia-Pacific and the European group of ETFs, (6) the European group of ETFs are more efficient in tracking their benchmarks than the Asia-Pacific group of ETFs. Moreover, (7) the study found evidence in support of pricing deviation of international ETFs. In particular, international ETFs mainly trade at a premium, regardless of the underlying markets they track. Finally, (8) our findings revealed that pricing inefficiency persists for two days for the majority of international ETFs even though the premium or discount slightly fade away moving from one to two lagged days.

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Chapter 6
Conclusion and summary

6.1 Introduction

This study is an endeavour to investigate (1) the market efficiency by analysing the *random behaviour and calendar anomalies* in the International ETFs; and (2) the performance dynamics of International ETFs by analysing their *returns and return volatilities, tracking abilities and pricing efficiencies*. More specifically, the study seeks answers to the following research questions such as (1) Do the returns of international ETFs follow a random walk? (2) Is the calendar effect present in the returns of International ETFs? (3) Is there any difference in the returns and return volatilities measured in trading prices and NAVs of International ETFs? (4) Is there any difference in the return volatilities during trading (intraday) and non-trading (overnight) hours of International ETFs? (5) Are International ETFs suffer with any tracking error, if yes, is it persistent over time and (6) Are International ETFs closely trade to their NAV and does the pricing inefficiency (if any) persist over time?

To this end, the study selected a sample of 56 US-listed international ETFs based on the two criteria. First, the *geographic focus* of the international ETFs must be Asia Pacific and European markets, as the study compares the market efficiency and performance of international ETFs based on the underlying region of the benchmarks. And second is that the *asset class focus* of the international ETFs must be equity, as different asset classes has different dynamics therefore we limit the scope of this study be selecting only those international ETFs which tracks the performance of equity-based tracking indices. Daily historical data of sample ETFs is downloaded from Bloomberg database for the 10 years' time span, from 3 January 2007 to 30 December 2016.

In regard to methods, the study employed the two most popular and powerful VR tests have been employed to investigate the random walk of international ETFs such as (1) Lo and MacKinlay (1988) individual VR test and (2) Chow and Denning (1993) multiple VR test. And for robustness of results, we also employed BDS test. And to determine the presence of calendar anomalies in the returns of International ETFs over time, the study used ARMA-GARCH model, after preliminary diagnostic tests such as Jarque-Bera test of normality, Augmented-Dickey Fuller test of unit root, Lagrange Multiplier test of ARCH effect, Pairwise Wilcoxon test. We estimate the return and volatility in trading price and NAV to distinguish their behaviour; and to compare the return volatility during the trading hours (intraday) and non-trading hours (i.e. overnight), we also calculate and compare return and volatility during intraday and overnight periods. Moreover, to evaluate the risk-adjusted performance, we employ capital asset pricing model (CAPM) model by regressing trading price returns and NAV returns of International ETFs on their corresponding benchmark returns after adjusting both with a risk-free return. Tracking errors in trading price returns and NAV returns are estimated using the two methods (1) the absolute difference in ETF and its benchmark returns and (2) the standard deviation of the difference in ETF and its benchmark returns; and second-order autoregressive model by regressing the tracking errors on the values of their two lagged days. To measure the pricing inefficiency of International ETFs, we use two methods (1) percentage change in closing price of ETFs and NAV and (2) OLS by regressing trading price of ETFs on its NAV; and to examine the persistence of pricing inefficiency in International ETFs, we regress the estimated price deviation on its two day lagged values using the second-order autoregressive model.

6.2 Key Findings

As long as the results related to the market efficiency of international ETFs are concerned, the study broadly suggests that the returns of International ETFs are not randomly generated and can be predicted through technical analysis and hence invalidate the weak form efficiency of international ETF market. And the main reason, for the rejection of RWH in the case of international ETFs, is the non-synchronous trading hours between the *ETF shares* and the *underlying securities* which induces *information asymmetry* and makes *creation/redemption process* ineffective. On examination of *calendar anomalies*, the study observe a time-varying "Monday effect" and "January effect" in the returns of international ETFs which shows that market efficiency evolves over time and thus consistent with AMH.

With regard to performance dynamics of international ETFs, we find that for daily returns and return volatilities of international ETFs, the *trading price returns* performs well for ETFs tracking the Asia-Pacific market while *NAV returns* are superior in the case of the European group of ETFs. In terms of the return volatilities, *trading price return volatilities* are higher than the *NAV return volatilities* in both the Asia-Pacific and the European group of international ETFs. Moreover, when we compare the intraday and overnight returns and return volatilities of international ETFs, we found that *overnight returns and return volatilities* both are higher than the *intraday returns and return volatilities*. The results of risk-adjusted performance reveal that NAV returns are better performance indicator of international ETFs than the trading price return. This is further confirmed when we investigate the tracking efficiency of international ETFs; we noted that the *NAV tracking errors* are lower than the *trading price tracking errors* for both the Asia-Pacific and the European group of ETFs. In comparing the tracking efficiency of ETFs based on their underlying regions, we found that the European group of

ETFs are more efficient in tracking their benchmarks than the Asia-Pacific group of ETFs. With regard to pricing efficiency, the study found evidence in support of pricing deviation of international ETFs. In particular, international ETFs mainly trade at a premium, regardless of the underlying markets they track. Finally, our findings revealed that pricing inefficiency persists for two days for the majority of international ETFs even though the premium or discount slightly fade away moving from one to two lagged days.

6.3 Contributions and practical implications

The results of this study have several important contributions and practical implications for investors and practitioners.

First, As a pioneer study investigating the random walk, calendar anomalies and performance dynamics of international ETFs, it not only contributes to the ETF literature but it also contribute to the literature on random walk, calendar anomalies, efficient market hypothesis and adaptive market hypothesis. This is the first study to employ the variance ratios test to examine the random walk in international ETF returns and used ARMA-GARCH model to determine the effect of calendar anomalies in international ETF returns.

Second, the conception related to the random walk behaviour of the returns of international ETFs is vital for *finance and investment theories* in general and for *investment strategies* in special. The issue is equally important to both the academics and investors. Academics seek to understand the price behaviour of international ETFs and the risk-return models relying on the random walk behaviour of ETF returns. For investors, the non-randomness in the returns enable them to identify the trends to exploit by using an appropriate trading strategy such as '*trend following strategy*' or '*value investing strategy*' in response to the positive or negative autocorrelation, respectively.

Third, the understanding of calendar anomalies in the returns of international ETFs, enable investor to apply investment strategies based on the behaviour of calendar anomalies in the market. Since EMH contradicts with calendar anomalies, this is the first study that link the behaviour of calendar anomalies over time with the recently formed AMH. According to AMH, market efficiency is not an all-or-nothing phenomena rather the degree of market efficiency changes over time and thus calendar anomalies can coexist with EMH.

Fourth, the findings provide an understanding of distinguishing behaviour of returns and volatilities estimated in trading prices and NAVs of international ETFs. ETF investors receive the NAV returns on their investments (Rompotis, 2015) while most of the retail investors calculate returns in trading price which are more frequently and easily available, comparing to the NAVs. This study is therefore has a significant importance, as it answers the very basic concern of investors that which of the two (i.e. trading price return or NAV return) is a better replicator of benchmark returns.

Fifth, the results related to the intraday and overnight comparison of returns and return volatilities of international ETFs, enable investors and practitioners to choose the optimal investment strategy. Investors can establish a strategy considering the higher overnight return volatility and lower intraday return volatility of international ETFs due to asynchronous trading hours between the ETF and benchmark markets.

Sixth, the larger tracking errors have the material effect on ETF return and are, therefore, a major concern for investors. They (large tracking errors) make ETF ineffective and unattractive by failing to offer the exposure to the benchmark indices. Our findings, on the magnitude and persistence of tracking errors, help investors to ensure the higher tracking ability prior to investing in the international ETFs.

Seventh, the pricing inefficiency provides an arbitrage opportunity for large investors. In this respect, our results provide an understanding of the dynamics of pricing inefficiency of international ETFs, which enable investors to implement the idle investment strategy for earning an abnormal return from potential arbitrage opportunities (as and when occur).

Although Shin and Soydemir (2010) explored the two issues i.e. tracking and pricing inefficiencies of International ETFs but with relatively small sample (i.e. 20 international ETFs) and for a short time-horizon (i.e. 4 years). However, in our study, we used a large sample of 56 US-listed international ETFs exclusively tracking 28 Asia-Pacific and 28 European indices with a long time-horizon of 10 years from 2007 to 2010. Our sample is unique because it only contains the iShare ETFs issued by the world's largest ETF issuer, the BlackRock and all the sample ETFs are actively traded with a trading frequency of over 90%. Moreover, Shin and Soydemir (2010) only examined the two aforementioned issues using NAV returns while we not only examined them using NAV-return but also used the trading price return, as Tse and Matinez (2007) argue that the differences between price return variance and the NAV return variance indicate the existence of *noise trading* of international ETFs.

Thus, this study comprehensively analysed the market efficiency and performance dynamics of international ETFs by analysing the return and return volatility, tracking ability and pricing efficiency of international ETFs. The study equips investors and practitioners with the substantial performance-related information that is useful to make better-informed investment decisions.

6.4 Limitations and future research

Although, this study addresses significant concerns of the investors and provide useful and credible empirical answers of those concerns, however, there is still room to research on a number of issues of International ETFs.

First, this study only examined the two calendar anomalies such as "Monday effect" and "January effect". Other calendar anomalies such as (1) Holiday effect, (2) Turn-of-the-month can be examined in future focusing international ETFs. Second, it focuses on the equity based international ETFs. Future researches can be undertaken considering international ETFs based on other asset classes such as Fixed Income, Commodity and Real Estate Investment Trust (REIT).

Third, an event study can be conducted to understand the effect of the introduction of International ETFs on the volatility of underlying stocks. This can be done by examining the volatility of foreign benchmark indices before and after the introduction of corresponding International ETFs over the suitable time windows.

Fourth, macroeconomic variables can be incorporated in the examination of trading behaviour of International ETFs. In this study, we solely focused on the market microstructure of the International ETFs and, therefore, future research can be performed by investigating that how developments in underlying markets at the macro level affect the performance dynamics of corresponding International ETFs. Indicatively, the macroeconomic variables such as the GDP rates, interest rates, inflation rates, unemployment rates, exchange rates, sovereign indebtedness, international trade and natural resources reserves can be incorporated in the future studies.

Finally, contagion effect can also be studied by using the international ETF data to examine whether and how the 2007-2008 financial crisis triggered in the US was passed through to European and Asia-Pacific economies via the corresponding international ETFs.

Appendix A

Monday effect in the trading price returns

A.1 Monday effect in trading price returns of ALL ETFs

Appendix A- 1: Monday effect in the trading price returns of ALL ETFs

	Full sample period	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Mean Eq.											
Monday	-0.0572*** (0.0000)	0.0775** (0.0465)	-0.1613*** (0.0083)	0.1059 (0.876)	0.121*** (0.0006)	0.0039 (0.9158)	0.1098*** (0.0002)	0.0704*** (0.0039)	-0.0062 (0.7706)	-0.0512** (0.0288)	0.0207 (0.2848)
Tuesday	0.0762*** (0.0000)	0.0566 (0.1377)	-0.1487** (0.0118)	0.3461 (0.4206)	0.1024*** (0.0034)	-0.0953** (0.0126)	0.082*** (0.0046)	-0.0144 (0.5202)	-0.0136 (0.5113)	-0.0307 (0.1696)	0.0083 (0.6695)
Wednesday	0.0357*** (0.0000)	0.0709** (0.0421)	-0.1899*** (0.0002)	0.3864 (0.6177)	0.0958*** (0.0033)	-0.084** (0.0147)	0.1174*** (0.0000)	0.0859*** (0.0002)	-0.0199 (0.3313)	0.0158 (0.4806)	0.0214 (0.3032)
Thursday	0.022** (0.0228)	0.0365 (0.3673)	-0.2182*** (0.0005)	0.3128 (0.3555)	0.1067*** (0.0028)	-0.0615 (0.1026)	0.0713** (0.0165)	0.0213 (0.3431)	-0.0247 (0.2316)	0.0219 (0.3456)	-0.0093 (0.6405)
Friday	0.0068 (0.4481)	0.0867** (0.0138)	-0.1176** (0.019)	0.367 (0.6268)	0.1676*** (0.0000)	-0.0914** (0.0114)	0.0681** (0.0168)	0.0853*** (0.0004)	-0.022 (0.3089)	-0.0376* (0.0793)	0.0054 (0.7835)
AR(1)	0.7711*** (0.0000)	-0.0743 (0.1826)	0.3775*** (0.0007)	-0.3224** (0.0327)	0.9362*** (0.0000)	-0.6895*** (0.0000)	0.6398*** (0.0000)	0.3779*** (0.0083)	-0.2336*** (0.0002)	-0.704*** (0.0000)	-0.9367*** (0.0000)
MA(1)	-0.8083*** (0.0000)	-0.1341** (0.012)	-0.4681*** (0.0000)	0.2914* (0.0651)	-0.9559*** (0.0000)	0.6458*** (0.0000)	-0.6813*** (0.0000)	-0.432*** (0.0018)	0.178*** (0.0045)	0.7283*** (0.0000)	0.9182*** (0.0000)
Variance Eq.											
Constant	0.0671*** (0.0000)	0.0712*** (0.0000)	0.1262*** (0.0000)	0.3973 (0.8739)	0.1293*** (0.0000)	0.0881*** (0.0000)	0.037 (0.5871)	0.0303** (0.0101)	0.0246*** (0.0001)	0.111*** (0.0000)	0.1493*** (0.0000)
ARCH	0.1225*** (0.0000)	0.1264*** (0.0000)	0.165*** (0.0000)	0.0075 (0.6246)	0.1063*** (0.0000)	0.1207*** (0.0000)	0.0628 (0.3593)	0.0554*** (0.0000)	0.0775*** (0.0000)	0.1119*** (0.0000)	0.1795*** (0.0000)
GARCH	0.8567*** (0.0000)	0.8544*** (0.0000)	0.83*** (0.0000)	0.9915*** (0.0000)	0.8641*** (0.0000)	0.8694*** (0.0000)	0.9218*** (0.0000)	0.9268*** (0.0000)	0.9071*** (0.0000)	0.8331*** (0.0000)	0.7497*** (0.0000)

Appendix A-1 reports the results of Monday effect in the returns of All Sample ETFs.

A.2 Monday effect in trading price returns of Asia-Pacific ETFs

Appendix A- 2: Monday effect in the trading price returns of Asia Pacific ETFs

	Full sample period	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Mean Eq.											
Monday	0.0001 (0.9948)	0.0991 (0.1533)	-0.1009 (0.3106)	0.0824 (0.7839)	0.1605*** (0.001)	-0.0619 (0.2423)	0.0889** (0.0328)	-0.0442 (0.1963)	0.003 (0.9241)	-0.0771** (0.0268)	0.0016 (0.9541)
Tuesday	0.0326*** (0.0093)	0.0544 (0.444)	-0.3041*** (0.001)	0.4808* (0.0973)	0.1214*** (0.0054)	-0.0173 (0.7425)	0.1062*** (0.0066)	0.0064 (0.86)	0.0384 (0.1756)	-0.0002 (0.9948)	0.026 (0.3049)
Wednesday	0.0096 (0.445)	0.1564** (0.0181)	-0.1714* (0.0711)	0.0561 (0.8313)	0.1295*** (0.0035)	-0.0944** (0.0411)	0.1181*** (0.0013)	0.0348 (0.3242)	0.0252 (0.4006)	0.0076 (0.8059)	0.0224 (0.3944)
Thursday	0.0331** (0.0129)	0.0265 (0.6886)	-0.2317** (0.0156)	0.4984* (0.0739)	0.1428*** (0.0017)	-0.0811* (0.0759)	0.0804** (0.021)	0.0121 (0.7395)	0.0398 (0.1812)	-0.036 (0.2875)	0.0046 (0.8597)
Friday	0.0128 (0.3199)	0.0731 (0.2435)	-0.178* (0.0504)	0.4955* (0.0658)	0.1024** (0.0367)	-0.0618 (0.2304)	0.0446 (0.2371)	0.0124 (0.7094)	-0.0225 (0.4525)	-0.0848** (0.0213)	0.0061 (0.8217)
AR(1)	0.7193*** (0.0000)	-0.0712 (0.3513)	0.3754*** (0.0001)	-0.3922*** (0.0008)	0.8637*** (0.0000)	-0.7887*** (0.0000)	0.56*** (0.0000)	0.6602*** (0.0000)	0.043 (0.751)	-0.4632*** (0.0000)	0.9844*** (0.0000)
MA(1)	-0.7583*** (0.0000)	-0.1494** (0.0374)	-0.5245*** (0.0000)	0.3491*** (0.0032)	-0.8986*** (0.0000)	0.7377*** (0.0000)	-0.6032*** (0.0000)	-0.6955*** (0.0000)	-0.1045 (0.4329)	0.5118*** (0.0000)	-0.994*** (0.0000)
Variance Eq.											
Constant	0.0648*** (0.0000)	0.0635*** (0.0026)	0.1499*** (0.0000)	0.1363 (0.5107)	0.1082*** (0.0000)	0.0899*** (0.0000)	0.0338 (0.5794)	0.051*** (0.0000)	0.014** (0.0253)	0.1487*** (0.0001)	0.1422*** (0.0000)
ARCH	0.1158*** (0.0000)	0.1174*** (0.0000)	0.1574*** (0.0000)	0.0076** (0.027)	0.0845*** (0.0000)	0.1102*** (0.0000)	0.0531 (0.3762)	0.0844*** (0.0000)	0.0538*** (0.0001)	0.129*** (0.0000)	0.133*** (0.0000)
GARCH	0.8625*** (0.0000)	0.874*** (0.0000)	0.8358*** (0.0000)	0.9897*** (0.0000)	0.8743*** (0.0000)	0.872*** (0.0000)	0.9271*** (0.0000)	0.8907*** (0.0000)	0.9364*** (0.0000)	0.8016*** (0.0000)	0.7903*** (0.0000)

Appendix A-2 reports the results of Monday effect in the returns of Asia Pacific ETFs.

A.3 Monday effect in trading price returns of European ETFs

Appendix A- 3: Monday effect in the trading price returns of European ETFs

	Full sample period	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Mean Eq.											
Monday	0.0095 (0.4649)	0.0410 (0.3541)	-0.0936 (0.1654)	0.3190 (0.7053)	0.0844 (0.144)	-0.0219 (0.7002)	0.0602 (0.192)	0.0674** (0.0305)	-0.0344 (0.253)	-0.050 (0.1334)	0.010 (0.6974)
Tuesday	0.0306*** (0.0096)	0.1251*** (0.009)	-0.0506 (0.4749)	0.3788 (0.6297)	0.0694 (0.1727)	-0.1373** (0.0125)	0.1164*** (0.0066)	0.1183*** (0.0001)	-0.0498* (0.0814)	0.0013 (0.9622)	-0.0073 (0.7735)
Wednesday	0.0059 (0.6383)	0.05 (0.324)	-0.1772*** (0.0096)	0.5498 (0.4553)	0.1277** (0.0172)	-0.0026 (0.9652)	0.0794* (0.0637)	0.0747** (0.0155)	-0.0796*** (0.0047)	0.0145 (0.6225)	0.034 (0.201)
Thursday	0.0182 (0.1397)	0.0214 (0.6185)	-0.2151*** (0.0004)	-0.2134 (0.7668)	0.1216** (0.0302)	-0.1055* (0.0664)	0.128*** (0.0023)	0.032 (0.2904)	-0.0304 (0.305)	0.0169 (0.5841)	-0.0113 (0.67)
Friday	0.0308** (0.0134)	0.0361 (0.4244)	-0.1628** (0.0272)	0.3334 (0.6444)	0.1787*** (0.0009)	-0.0593 (0.2748)	0.0856* (0.0775)	0.1181*** (0.0001)	-0.0515* (0.0782)	0.0413 (0.1704)	0.0051 (0.8512)
AR(1)	0.8065*** (0.0000)	-0.0658 (0.4383)	0.2555 (0.1015)	-0.3896*** (0.0000)	-0.5014*** (0.0000)	-0.5252** (0.0103)	0.6874*** (0.0000)	0.2234*** (0.004)	-0.4028*** (0.0000)	0.8742*** (0.0000)	-0.9192*** (0.0000)
MA(1)	-0.843*** (0.0000)	-0.1408* (0.0861)	-0.2986* (0.057)	0.3607*** (0.0000)	0.4929*** (0.0000)	0.4872** (0.0175)	-0.7276*** (0.0000)	-0.3045*** (0.0000)	0.3462*** (0.0000)	-0.9223*** (0.0000)	0.8979*** (0.0000)
Variance Eq.											
Constant	0.0683*** (0.0000)	0.0798*** (0.0000)	0.1089*** (0.0000)	0.3904 (0.9651)	0.2019*** (0.0000)	0.0767*** (0.0002)	0.0462 (0.2173)	0.0103*** (0.0000)	0.0338*** (0.0013)	0.0931*** (0.0000)	0.1478*** (0.0000)
ARCH	0.128*** (0.0000)	0.1064*** (0.0000)	0.1627*** (0.0000)	0.0000 (1.0000)	0.1158*** (0.0000)	0.1142*** (0.0000)	0.0585** (0.0136)	0.0266*** (0.0000)	0.0974*** (0.0000)	0.0979*** (0.0000)	0.2143*** (0.0000)
GARCH	0.8523*** (0.0000)	0.8553*** (0.0000)	0.834*** (0.0000)	0.999*** (0.0000)	0.8515*** (0.0000)	0.8803*** (0.0000)	0.9259*** (0.0000)	0.9666*** (0.0000)	0.8831*** (0.0000)	0.8525*** (0.0000)	0.7238*** (0.0000)

Appendix A-3 reports the results of Monday effect in the returns of European ETFs.

Appendix B

January effect in the trading price returns

B.1 January effect in the trading price returns of ALL ETFs

Appendix B- 1: January effect in the trading price returns of ALL ETFs

	Full sample period	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Mean Eq.											
January	0.0035 (0.813)	0.0523 (0.1122)	-0.0194 (0.8219)	0.4106** (0.0468)	0.1178*** (0.0073)	-0.1357** (0.0141)	0.1312*** (0.0016)	0.0724** (0.0432)	-0.0309 (0.3993)	-0.0084 (0.7873)	-0.0352 (0.2946)
February	0.1183*** (0.0000)	-0.0570 (0.1322)	-0.0527 (0.4933)	0.1747 (0.4743)	0.1342** (0.0155)	0.0115 (0.8281)	0.1051** (0.0406)	0.0395 (0.1897)	-0.0808** (0.0299)	-0.0512 (0.1586)	-0.0433 (0.1739)
March	0.0889*** (0.0000)	0.1303*** (0.0003)	-0.0248 (0.7726)	0.2143 (0.5025)	0.0887* (0.0518)	-0.0235 (0.6261)	0.1523*** (0.0002)	0.0408 (0.1748)	0.0081 (0.7944)	-0.0121 (0.7088)	0.0013 (0.9628)
April	0.1118*** (0.0000)	-0.0276 (0.6195)	-0.2616*** (0.0003)	0.5842** (0.0141)	0.1249*** (0.0056)	-0.0144 (0.7962)	0.0091 (0.818)	0.1059*** (0.0016)	-0.0461 (0.1063)	-0.0738** (0.022)	0.0162 (0.5367)
May	-0.0563*** (0.0000)	0.1316*** (0.0026)	-0.2722*** (0.0000)	0.2272 (0.3018)	0.1096*** (0.0076)	-0.1032** (0.0403)	0.0698 (0.133)	0.0811*** (0.0068)	-0.047* (0.0924)	-0.013 (0.6796)	0.0087 (0.7663)
June	-0.0827*** (0.0000)	0.1598*** (0.0012)	-0.3181*** (0.0000)	0.2863 (0.2871)	0.1632*** (0.0001)	-0.047 (0.2824)	0.0623 (0.1566)	0.0078 (0.792)	-0.0032 (0.9281)	0.0148 (0.6297)	0.0125 (0.6983)
July	0.069*** (0.0000)	0.0871* (0.0867)	-0.1866** (0.0466)	0.3273 (0.104)	0.0789* (0.0766)	-0.1063** (0.0151)	0.1709*** (0.0001)	0.077** (0.0161)	0.0502* (0.0998)	0.0372 (0.1477)	-0.0126 (0.614)
August	-0.0471*** (0.0000)	0.0323 (0.4157)	-0.0757 (0.2235)	0.512* (0.0889)	0.1632*** (0.0000)	-0.0508 (0.235)	0.0999*** (0.0017)	0.0502* (0.0857)	-0.0323 (0.2111)	-0.0403 (0.1551)	0.0304 (0.295)
September	0.0583*** (0.0012)	-0.0181 (0.6869)	-0.2028*** (0.0022)	0.5556* (0.0907)	0.1537*** (0.0001)	-0.1511*** (0.0027)	0.0442 (0.2539)	-0.0097 (0.7691)	-0.0119 (0.6374)	-0.0406 (0.1501)	-0.0027 (0.9238)
October	0.05*** (0.0000)	0.0709* (0.0526)	-0.356*** (0.0000)	-0.0821 (0.7795)	0.067 (0.129)	-0.1065* (0.0591)	0.1309*** (0.0024)	0.0707** (0.0382)	-0.0251 (0.4652)	-0.0057 (0.8469)	0.0568** (0.0287)
November	-0.0428*** (0.0000)	0.0868** (0.016)	-0.1515** (0.0272)	0.1633 (0.703)	0.1069** (0.0134)	0.0115 (0.8392)	0.0198 (0.5698)	0.0181 (0.6143)	0.0317 (0.2878)	-0.0056 (0.865)	0.0018 (0.959)
December	-0.0164 (0.1832)	0.1381*** (0.004)	-0.029 (0.6412)	0.4502* (0.0817)	0.1145*** (0.0044)	-0.0992** (0.0369)	0.0958** (0.0141)	0.0405 (0.2186)	-0.0311 (0.1892)	-0.0032 (0.9152)	0.0609** (0.0397)

AR(1)	0.7814*** (0.0000)	-0.0612 (0.2849)	0.4543*** (0.0000)	-0.3088*** (0.0000)	0.9311*** (0.0000)	-0.6843*** (0.0000)	0.643*** (0.0000)	0.3924*** (0.0024)	-0.2319*** (0.001)	-0.706*** (0.0000)	-0.9366*** (0.0000)
MA(1)	-0.8231*** (0.0000)	-0.1518*** (0.0056)	-0.5489*** (0.0000)	0.2787*** (0.0001)	-0.9518*** (0.0000)	0.6401*** (0.0000)	-0.6867*** (0.0000)	-0.4486*** (0.0003)	0.1755** (0.0141)	0.7303*** (0.0000)	0.9179*** (0.0000)
Variance Eq.											
Constant	0.0684*** (0.0000)	0.0727*** (0.0000)	0.1245*** (0.0000)	0.2948 (0.3513)	0.1293*** (0.0000)	0.0882*** (0.0000)	0.0375 (0.4939)	0.0302** (0.0104)	0.0247*** (0.0001)	0.1114*** (0.0000)	0.1498*** (0.0000)
ARCH	0.1224*** (0.0000)	0.1271*** (0.0000)	0.1674*** (0.0000)	0.0000 (1.0000)	0.1063*** (0.0000)	0.1213*** (0.0000)	0.0633 (0.2503)	0.0552*** (0.0000)	0.0771*** (0.0000)	0.1121*** (0.0000)	0.1795*** (0.0000)
GARCH	0.8559*** (0.0000)	0.8528*** (0.0000)	0.8282*** (0.0000)	0.999*** (0.0000)	0.8641*** (0.0000)	0.8689*** (0.0000)	0.921*** (0.0000)	0.927*** (0.0000)	0.9074*** (0.0000)	0.8328*** (0.0000)	0.7493*** (0.0000)

Appendix B-1 reports the results of January effect in the returns of All Sample ETFs.

B.2 January effect in the trading price returns of Asia-Pacific ETFs

Appendix B- 2: January effect in the trading price returns of Asia Pacific ETFs

	Full sample period	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Mean Eq.											
January	0.0005 (0.9759)	0.1097 (0.1309)	-0.1612** (0.0441)	0.3962 (0.6272)	0.1962*** (0.0002)	-0.0582 (0.464)	0.0898 (0.1417)	-0.0287 (0.4876)	-0.0034 (0.9433)	-0.0438 (0.4681)	-0.0332 (0.5563)
February	0.0043 (0.8353)	0.0149 (0.7829)	-0.431*** (0.0000)	0.2221 (0.8424)	0.0369 (0.5257)	-0.0548 (0.56)	0.0461 (0.5222)	0.0266 (0.5495)	0.0271 (0.6172)	-0.062 (0.2852)	-0.0338 (0.4889)
March	0.0374** (0.0357)	0.1432** (0.0169)	-0.1812 (0.1628)	0.2427 (0.8281)	0.1443*** (0.0041)	-0.0361 (0.5186)	0.0852** (0.0376)	-0.0612 (0.3424)	0.0636** (0.0478)	-0.0916** (0.039)	0.0231 (0.5707)
April	0.0379** (0.034)	-0.139 (0.1585)	-0.0343 (0.8254)	0.4678 (0.4176)	0.133** (0.0269)	-0.0871 (0.1147)	0.153** (0.0282)	0.1223*** (0.0036)	-0.0208 (0.6405)	-0.0818 (0.1153)	0.0304 (0.4401)
May	-0.0164 (0.405)	0.1646 (0.123)	-0.1416 (0.1816)	0.4738 (0.7316)	0.1921*** (0.002)	-0.0545 (0.3409)	0.0787* (0.0693)	0.0992** (0.0175)	-0.0424 (0.2708)	0.0000 (1.000)	0.0835** (0.0457)
June	-0.0016 (0.9345)	0.3747*** (0.0000)	-0.4158*** (0.0001)	0.0952 (0.8995)	0.0978* (0.0993)	0.0729 (0.3092)	0.0348 (0.4717)	0.0352 (0.4393)	0.0635 (0.1257)	0.0206 (0.7359)	0.0141 (0.745)
July	0.0605*** (0.0014)	0.0207 (0.8586)	-0.3499*** (0.0000)	0.5314 (0.7359)	0.1256 (0.103)	0.0129 (0.8074)	0.0827* (0.0776)	-0.0906* (0.0524)	-0.0029 (0.9401)	-0.008 (0.854)	-0.0062 (0.8622)
August	0.0225 (0.228)	-0.0591 (0.6283)	-0.0365 (0.7363)	0.3082 (0.7401)	0.0838 (0.1097)	-0.0878 (0.1345)	0.194*** (0.0007)	0.0666 (0.1993)	0.0377 (0.3901)	-0.1011** (0.0256)	-0.0001 (0.9977)
September	0.0221 (0.2409)	-0.1685** (0.0383)	0.0737 (0.3957)	-0.0596 (0.9462)	0.1475** (0.0202)	-0.1567*** (0.0077)	0.1583*** (0.0018)	-0.062 (0.3185)	-0.0227 (0.4614)	0.0027 (0.9535)	-0.0098 (0.834)
October	0.0412** (0.0134)	0.1742*** (0.0016)	0.1076 (0.2237)	0.5541 (0.7116)	0.1603*** (0.0024)	-0.1348** (0.0417)	0.0999*** (0.01)	0.0079 (0.8708)	-0.0185 (0.6316)	0.0071 (0.8789)	0.0517 (0.2525)
November	0.0005 (0.9734)	0.0301 (0.7023)	-0.1229* (0.0822)	0.320 (0.7352)	0.2666*** (0.0000)	0.1136 (0.276)	0.0372 (0.4835)	-0.0633 (0.1374)	0.0861* (0.0548)	-0.0598 (0.2411)	0.0419 (0.4348)
December	0.0049 (0.7705)	0.1566** (0.0217)	-0.5002*** (0.0000)	0.1944 (0.7476)	-0.0216 (0.7476)	-0.2011*** (0.0064)	-0.0253 (0.7402)	-0.0071 (0.8857)	0.0391 (0.3347)	-0.0207 (0.7022)	-0.0084 (0.8833)
AR(1)	0.7203*** (0.0000)	-0.0033 (0.975)	0.5419*** (0.0000)	-0.3927** (0.0169)	0.8374*** (0.0000)	-0.7803*** (0.0000)	0.5818*** (0.0000)	0.701*** (0.0000)	0.0622 (0.6846)	-0.468*** (0.0000)	-0.9459*** (0.0000)
MA(1)	-0.7598*** (0.0000)	-0.2324** (0.019)	-0.7043*** (0.0000)	0.35* (0.0556)	-0.8797*** (0.0000)	0.7277*** (0.0000)	-0.6285*** (0.0000)	-0.7404*** (0.0000)	-0.1259 (0.4028)	0.5166*** (0.0000)	0.9289*** (0.0000)
Variance Eq.											
Constant	0.065*** (0.0000)	0.071*** (0.0013)	0.1465*** (0.0000)	0.1356 (0.9359)	0.1078*** (0.0000)	0.0894*** (0.0000)	0.0318 (0.6311)	0.0508*** (0.0000)	0.0135** (0.0234)	0.1487*** (0.0003)	0.1471*** (0.0000)
ARCH	0.1158*** (0.0000)	0.1242*** (0.0000)	0.1672*** (0.0000)	0.0073 (0.4636)	0.0853*** (0.0000)	0.1099*** (0.0000)	0.0513 (0.4375)	0.0844*** (0.0000)	0.0539*** (0.0001)	0.1284*** (0.0000)	0.1417*** (0.0000)

GARCH	0.8624*** (0.0000)	0.8654*** (0.0000)	0.8259*** (0.0000)	0.9904*** (0.0000)	0.8733*** (0.0000)	0.8722*** (0.0000)	0.93*** (0.0000)	0.8909*** (0.0000)	0.9366*** (0.0000)	0.8021*** (0.0000)	0.7808*** (0.0000)

Appendix B-2 reports the results of January effect in the returns of Asia Pacific ETFs.

B.3 January effect in the trading price returns of European ETFs

Appendix B- 3: January effect in the trading price returns of European ETFs

	Full sample period	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Mean Eq.											
January	0.0206 (0.25)	0.0441 (0.379)	-0.0911 (0.3636)	0.6999 (0.4167)	0.1240 (0.2161)	0.0476 (0.4603)	0.15** (0.0435)	0.1139** (0.0173)	-0.0222 (0.6643)	-0.0563 (0.2137)	0.0691* (0.0964)
February	0.0456*** (0.0082)	-0.0756 (0.3873)	-0.1527 (0.1184)	0.0032 (0.9944)	0.0515 (0.5425)	-0.0987 (0.1736)	0.0846 (0.2518)	0.0532 (0.1638)	-0.0674 (0.1521)	0.0057 (0.8953)	0.0088 (0.8207)
March	0.0327** (0.0437)	0.030 (0.6291)	-0.1070 (0.2724)	0.0585 (0.937)	0.0170 (0.8181)	-0.1924*** (0.0026)	0.1372** (0.016)	0.1067*** (0.001)	0.0149 (0.7245)	-0.0664* (0.074)	0.0317 (0.3146)
April	0.0294* (0.0993)	0.1543*** (0.001)	-0.1522 (0.1169)	0.0188 (0.9689)	0.1565* (0.0541)	-0.0078 (0.922)	0.0606 (0.3423)	0.084** (0.0433)	-0.0677** (0.034)	-0.0617 (0.1497)	-0.0084 (0.8233)
May	0.0203 (0.2165)	0.1481*** (0.0044)	-0.0798 (0.5178)	0.9279 (0.1746)	0.1787** (0.0126)	0.0154 (0.8181)	0.0212 (0.7282)	0.0845** (0.0434)	-0.0559 (0.1225)	0.0151 (0.7214)	-0.0207 (0.4977)
June	-0.014 (0.4423)	0.0569 (0.2349)	-0.2215** (0.0378)	0.0485 (0.921)	0.0512 (0.5729)	-0.1927** (0.0148)	0.0768 (0.1977)	0.0713** (0.0486)	-0.0195 (0.6958)	-0.057 (0.1059)	-0.0491 (0.1725)
July	-0.0152 (0.3867)	-0.1057** (0.0212)	-0.2014*** (0.0066)	0.2363 (0.6273)	0.0607 (0.4608)	-0.1457** (0.0274)	0.2078*** (0.001)	0.0573 (0.1206)	-0.1039*** (0.0063)	0.0242 (0.4815)	0.0113 (0.8015)
August	0.0242 (0.1521)	0.0729** (0.0178)	-0.484*** (0.0000)	2.1094 (0.1969)	0.1585** (0.0163)	0.0861 (0.148)	0.1641*** (0.0021)	0.0688* (0.0992)	-0.0003 (0.9929)	-0.0072 (0.8211)	-0.0596 (0.1388)
September	0.0333* (0.0536)	0.0032 (0.9504)	-0.1775 (0.1349)	0.125 (0.7971)	0.025 (0.7498)	-0.1199* (0.0644)	0.043 (0.3571)	0.0939*** (0.0064)	-0.0406 (0.2662)	0.0912** (0.0237)	0.0332 (0.3642)
October	0.0347** (0.0458)	0.1468*** (0.0049)	-0.0485 (0.6677)	0.0194 (0.971)	0.1857*** (0.0043)	-0.0677 (0.3752)	0.0711 (0.3053)	0.1008** (0.0273)	-0.0785* (0.0906)	0.0661* (0.0589)	0.1239*** (0.0006)
November	0.0021 (0.9119)	0.1838*** (0.0000)	0.0087 (0.9296)	0.8532** (0.0319)	0.2372*** (0.0004)	0.0768 (0.2248)	0.0619 (0.444)	0.0681* (0.0555)	-0.0663 (0.1238)	0.0697* (0.0618)	0.0659** (0.0428)
December	0.0185 (0.2006)	-0.0117 (0.6924)	0.0166 (0.8791)	-0.4882 (0.4661)	0.1273 (0.1047)	-0.1851*** (0.0088)	0.0506 (0.3685)	0.0879** (0.0488)	-0.0991* (0.0577)	0.028 (0.3889)	-0.1002*** (0.0048)
AR(1)	0.8077*** (0.0000)	-0.0064 (0.9549)	0.3911 (0.2575)	-0.3624** (0.0208)	-0.4952*** (0.0000)	-0.4692*** (0.0002)	0.6968*** (0.0000)	0.2221** (0.0126)	-0.3982*** (0.0000)	0.8848*** (0.0000)	-0.9192*** (0.0000)
MA(1)	-0.8445*** (0.0000)	-0.2091* (0.0564)	-0.4409 (0.1983)	0.3182** (0.0402)	0.4854*** (0.0000)	0.4283*** (0.0006)	-0.7398*** (0.0000)	-0.3039*** (0.0004)	0.3399*** (0.0000)	-0.9357*** (0.0000)	0.8975*** (0.0000)
Variance Eq.											

Constant	0.0682*** (0.0000)	0.0835*** (0.0000)	0.1072*** (0.0000)	0.3864 (0.9601)	0.2012*** (0.0000)	0.0785*** (0.0002)	0.0462 (0.2145)	0.0103*** (0.0000)	0.0337*** (0.0011)	0.0918*** (0.0000)	0.1469*** (0.0000)
ARCH	0.1281*** (0.0000)	0.1096*** (0.0000)	0.1636*** (0.0000)	0.0000 (1.0000)	0.1154*** (0.0000)	0.1155*** (0.0000)	0.0586** (0.0126)	0.0263*** (0.0000)	0.0975*** (0.0000)	0.0967*** (0.0000)	0.2174*** (0.0000)
GARCH	0.8522*** (0.0000)	0.8494*** (0.0000)	0.8328*** (0.0000)	0.999*** (0.0000)	0.8519*** (0.0000)	0.8787*** (0.0000)	0.9256*** (0.0000)	0.9669*** (0.0000)	0.883*** (0.0000)	0.8541*** (0.0000)	0.7216*** (0.0000)

Appendix B-3 reports the results of January effect in the returns of European ETFs.

Appendix C

Monday effect in the NAV returns

C.1 Monday effect in the NAV returns of ALL ETFs

Appendix C- 1: Monday effect in the NAV returns of ALL ETFs

	Full sample period	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Mean Eq.											
Monday	-0.0166* (0.0709)	0.108*** (0.0008)	-0.1017* (0.0816)	0.454** (0.0392)	0.0673* (0.0521)	0.0052 (0.8903)	0.1059*** (0.0000)	0.0799*** (0.0006)	-0.0086 (0.6682)	-0.0502** (0.0162)	0.0031 (0.8757)
Tuesday	0.0534*** (0.0000)	0.0476 (0.1604)	-0.1957*** (0.0008)	0.3541* (0.071)	0.069** (0.0375)	-0.0795** (0.0304)	0.0433* (0.0989)	0.0227 (0.3038)	-0.006 (0.7402)	-0.0266 (0.2132)	0.0078 (0.682)
Wednesday	0.0299*** (0.0002)	0.102*** (0.002)	-0.1739*** (0.0004)	0.347 (0.1021)	0.1218*** (0.0003)	-0.0592* (0.0879)	0.1095*** (0.0000)	0.0834*** (0.0001)	-0.003 (0.8674)	0.0275 (0.171)	-0.0002 (0.9915)
Thursday	0.0227*** (0.0084)	0.0999*** (0.004)	-0.1437*** (0.0063)	0.2066 (0.3672)	0.1345*** (0.0000)	-0.0353 (0.3507)	0.0522** (0.0308)	0.0574*** (0.0071)	-0.0272 (0.1284)	0.0199 (0.3213)	-0.0006 (0.977)
Friday	0.0029 (0.7354)	0.0372 (0.2286)	-0.2317*** (0.0000)	0.175 (0.2997)	0.166*** (0.0000)	-0.0907** (0.01)	0.0827*** (0.0009)	0.072*** (0.0008)	-0.0062 (0.752)	-0.0161 (0.4357)	-0.001 (0.9587)
AR(1)	-0.2152** (0.0115)	-0.6883*** (0.0000)	0.5939*** (0.0000)	-0.7588*** (0.0000)	-0.8324*** (0.0000)	-0.1788 (0.1126)	0.6555*** (0.0000)	-0.5953*** (0.0009)	0.6782*** (0.0000)	-0.1303** (0.0201)	-0.4602** (0.0102)
MA(1)	0.2284*** (0.0073)	0.7066*** (0.0000)	-0.624*** (0.0000)	0.7664*** (0.0000)	0.8594*** (0.0000)	0.2074* (0.0671)	-0.6904*** (0.0000)	0.6218*** (0.0004)	-0.6639*** (0.0000)	0.1617*** (0.0038)	0.4841*** (0.0065)
Variance Eq.											
Constant	0.0563*** (0.0000)	0.0897*** (0.0000)	0.118*** (0.0000)	0.4018 (0.2012)	0.0834*** (0.0000)	0.0568*** (0.0000)	0.0176 (0.1321)	0.0503*** (0.0000)	0.0277*** (0.0022)	0.1005*** (0.0000)	0.1296*** (0.0000)
ARCH	0.1178*** (0.0000)	0.1363*** (0.0000)	0.1688*** (0.0000)	0.0157*** (0.0002)	0.0982*** (0.0000)	0.104*** (0.0000)	0.0626*** (0.0006)	0.0732*** (0.0000)	0.0791*** (0.0000)	0.1053*** (0.0000)	0.143*** (0.0000)
GARCH	0.8622*** (0.0000)	0.8158*** (0.0000)	0.8302*** (0.0000)	0.9833*** (0.0000)	0.8705*** (0.0000)	0.8854*** (0.0000)	0.933*** (0.0000)	0.8935*** (0.0000)	0.8994*** (0.0000)	0.8372*** (0.0000)	0.7904*** (0.0000)

Appendix C-1 reports the results of Monday effect in the returns of All Sample ETFs.

C.2 Monday effect in the NAV returns of Asia Pacific ETFs

Appendix C- 2: Monday effect in the NAV returns of Asia Pacific ETFs

	Full sample period	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Mean Eq.											
Monday	0.0158 (0.2008)	0.1307** (0.0182)	-0.2325*** (0.004)	0.2259 (0.3164)	0.1034** (0.0148)	-0.0254 (0.5963)	0.0665* (0.0558)	-0.0164 (0.6049)	0.0003 (0.9914)	-0.0747** (0.0133)	-0.0024 (0.9329)
Tuesday	0.0133 (0.2394)	0.0895 (0.1526)	-0.2024** (0.014)	0.4959** (0.0129)	0.1151*** (0.0034)	-0.0601 (0.1927)	0.0833*** (0.008)	-0.0053 (0.8693)	0.0282 (0.2872)	-0.0083 (0.7825)	0.0406 (0.1096)
Wednesday	0.0105 (0.3853)	0.1096** (0.0377)	-0.1996** (0.0185)	0.1636 (0.4323)	0.127*** (0.0016)	-0.1185*** (0.0097)	0.1046*** (0.0014)	0.047 (0.1106)	0.0625** (0.0193)	0.0002 (0.9954)	-0.0125 (0.6609)
Thursday	0.0248** (0.0331)	0.1823*** (0.0013)	-0.306*** (0.0004)	0.349 (0.1131)	0.1649*** (0.0006)	-0.0392 (0.4203)	0.0834*** (0.005)	0.0286 (0.3906)	-0.0015 (0.9511)	-0.0224 (0.4521)	0.0244 (0.3967)
Friday	0.0162 (0.1648)	0.0129 (0.8175)	-0.2404*** (0.001)	0.4189** (0.0225)	0.0993** (0.0281)	-0.0219 (0.6385)	0.032 (0.2989)	0.0427 (0.1388)	-0.0008 (0.9777)	-0.0511* (0.0999)	-0.0206 (0.4448)
AR(1)	0.0323 (0.6721)	-0.692*** (0.0000)	-0.7894*** (0.0000)	0.5289** (0.0313)	-0.8724*** (0.0000)	-0.0113 (0.934)	-0.3888*** (0.0001)	-0.1227 (0.1667)	0.6541 (0.2449)	-0.0835 (0.3776)	0.0846 (0.4522)
MA(1)	-0.0091 (0.9055)	0.7475*** (0.0000)	0.7385*** (0.0004)	-0.4934* (0.0522)	0.8892*** (0.0000)	0.0497 (0.7139)	0.364*** (0.0003)	0.1769** (0.0447)	-0.6442 (0.2584)	0.1395 (0.1426)	-0.0554 (0.6262)
Variance Eq.											
Constant	0.0521*** (0.0000)	0.0924*** (0.0002)	0.1847*** (0.0000)	0.1477 (0.1195)	0.0746*** (0.0000)	0.0651*** (0.0000)	0.0192* (0.0959)	0.0476*** (0.0000)	0.0199** (0.0449)	0.1505*** (0.0012)	0.0614*** (0.0056)
ARCH	0.1103*** (0.0000)	0.1277*** (0.0000)	0.1614*** (0.0000)	0.0109*** (0.0074)	0.0978*** (0.0000)	0.1013*** (0.0000)	0.0617*** (0.0001)	0.0977*** (0.0000)	0.0668*** (0.0002)	0.1269*** (0.0000)	0.0726*** (0.0000)
GARCH	0.8684*** (0.0000)	0.8378*** (0.0000)	0.8272*** (0.0000)	0.9881*** (0.0000)	0.8588*** (0.0000)	0.8799*** (0.0000)	0.9266*** (0.0000)	0.8763*** (0.0000)	0.9159*** (0.0000)	0.7863*** (0.0000)	0.8918*** (0.0000)

Appendix C-2 reports the results of Monday effect in the NAV returns of Asia Pacific ETFs.

C.3 Monday effect in the NAV returns of European ETFs

Appendix C- 3: Monday effect in the NAV returns of European ETFs

	Full sample period	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Mean Eq.											
Monday	0.0237* (0.0605)	0.0556 (0.1647)	-0.1438** (0.022)	0.1934 (0.7675)	0.1228** (0.0358)	-0.0327 (0.5761)	0.1217*** (0.0055)	0.1118*** (0.0001)	-0.0176 (0.5203)	-0.0175 (0.5782)	0.0147 (0.5825)
Tuesday	0.0301*** (0.0093)	0.0765* (0.0686)	-0.0164 (0.8192)	0.4953 (0.3783)	0.0194 (0.7218)	-0.0711 (0.2073)	0.0661* (0.0835)	0.1234*** (0.0000)	-0.0177 (0.4967)	0.0201 (0.4624)	-0.0073 (0.7902)
Wednesday	0.0167 (0.1629)	0.0975** (0.0203)	-0.1495** (0.0181)	0.4252 (0.4939)	0.1096** (0.038)	-0.0211 (0.7115)	0.0879** (0.0392)	0.1129*** (0.0002)	-0.0479* (0.0716)	-0.0013 (0.9665)	0.0275 (0.3372)
Thursday	0.0131 (0.2763)	0.0253 (0.5275)	-0.1808*** (0.0032)	-0.2376 (0.6803)	0.1185** (0.0264)	-0.075 (0.1807)	0.0671 (0.1103)	0.0358 (0.1899)	-0.0546** (0.044)	0.0355 (0.2124)	-0.0195 (0.4707)
Friday	0.031** (0.0122)	0.0463 (0.2938)	-0.0915 (0.2151)	0.1076 (0.8494)	0.1227** (0.0376)	-0.0573 (0.2864)	0.1016** (0.0264)	0.0867*** (0.004)	-0.0404 (0.1446)	0.0206 (0.4916)	-0.0155 (0.5746)
AR(1)	-0.4283** (0.0172)	0.6939*** (0.0000)	-0.9596*** (0.0000)	-0.5893*** (0.0077)	-0.785*** (0.0000)	-0.2859** (0.0338)	0.6632*** (0.0000)	0.9302*** (0.0000)	-0.9292*** (0.0000)	-0.1491** (0.0132)	-0.6016*** (0.0000)
MA(1)	0.435** (0.0153)	-0.7576*** (0.0000)	0.9371*** (0.0000)	0.5815*** (0.0072)	0.8264*** (0.0000)	0.3095** (0.0232)	-0.715*** (0.0000)	-0.9579*** (0.0000)	0.9203*** (0.0000)	0.1628*** (0.0058)	0.6321*** (0.0000)
Variance Eq.											
Constant	0.0623*** (0.0000)	0.0962*** (0.0000)	0.081*** (0.0001)	0.4168 (0.9188)	0.1587*** (0.0000)	0.0467*** (0.0000)	0.032** (0.0198)	0.0325*** (0.0043)	0.0447*** (0.0091)	0.0807*** (0.0000)	0.1432*** (0.0000)
ARCH	0.1238*** (0.0000)	0.1212*** (0.0000)	0.1583*** (0.0000)	0 (1)	0.0946*** (0.0000)	0.0919*** (0.0000)	0.0486*** (0.0000)	0.0382*** (0.0000)	0.0958*** (0.0000)	0.0907*** (0.0000)	0.1887*** (0.0000)
GARCH	0.8563*** (0.0000)	0.809*** (0.0000)	0.8407*** (0.0000)	0.999*** (0.0000)	0.8588*** (0.0000)	0.9014*** (0.0000)	0.9428*** (0.0000)	0.937*** (0.0000)	0.8715*** (0.0000)	0.8634*** (0.0000)	0.7484*** (0.0000)

Appendix C-3 reports the results of Monday effect in the NAV returns of European ETFs.

Appendix D

January effect in the NAV returns

D.1 January effect in the NAV returns of ALL ETFs

Appendix D- 1: January effect in the NAV returns of ALL ETFs

	Full sample period	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Mean Eq.											
January	-0.0215	0.0736**	-0.0822	0.4919**	0.1066**	-0.0986*	0.1209***	0.075**	-0.0353	-0.0184	-0.0276
	(0.1915)	(0.0289)	(0.3744)	(0.0115)	(0.0231)	(0.0551)	(0.002)	(0.0442)	(0.3558)	(0.5212)	(0.417)
February	0.1439***	-0.0388	-0.0777	-0.1265	0.1162**	0.0301	0.0825**	0.054	-0.0835**	-0.0369	-0.0554*
	(0.0000)	(0.3383)	(0.3107)	(0.5546)	(0.0424)	(0.5787)	(0.0456)	(0.1407)	(0.015)	(0.3061)	(0.0521)
March	0.0698***	0.1307***	-0.0402	0.4657	0.0812	-0.0139	0.1236***	0.0492*	-0.0007	-0.0252	0.0118
	(0.0000)	(0.0003)	(0.626)	(0.102)	(0.1066)	(0.7693)	(0.0056)	(0.0976)	(0.9818)	(0.4458)	(0.7013)
April	0.1121***	-0.0034	-0.22***	0.3044	0.1319***	-0.0017	0.0251	0.1143***	-0.0272	-0.0744**	0.0146
	(0.0000)	(0.9466)	(0.0036)	(0.1957)	(0.0045)	(0.9775)	(0.4697)	(0.0004)	(0.3221)	(0.0251)	(0.5574)
May	-0.0457***	0.1343***	-0.2563***	0.3451**	0.0983**	-0.087*	0.0773**	0.0958***	-0.0492*	-0.0012	-0.0119
	(0.0000)	(0.0029)	(0.0000)	(0.0365)	(0.0398)	(0.0952)	(0.0388)	(0.0006)	(0.071)	(0.9676)	(0.6786)
June	-0.0785***	0.1714***	-0.3061***	0.2476	0.1573***	-0.0239	0.0438	0.0297	0.007	0.0364	-0.0006
	(0.0000)	(0.0018)	(0.0001)	(0.2665)	(0.0006)	(0.5789)	(0.2634)	(0.3098)	(0.841)	(0.2048)	(0.9846)
July	0.0906***	0.07	-0.2273**	0.2719*	0.0783	-0.1113**	0.1374***	0.0655**	0.0757***	0.0285	-0.0183
	(0.0000)	(0.1579)	(0.0115)	(0.0979)	(0.1243)	(0.0144)	(0.0005)	(0.0395)	(0.0071)	(0.2464)	(0.4757)
August	-0.0553***	0.0546	-0.0648	0.5134**	0.1565***	-0.0545	0.0898***	0.0545*	-0.0179	-0.0191	0.0096
	(0.0000)	(0.1854)	(0.3077)	(0.0376)	(0.0001)	(0.2088)	(0.0052)	(0.0701)	(0.4951)	(0.485)	(0.7527)
September	0.0334*	0.0002	-0.2249***	0.3813	0.1526***	-0.1303***	0.0464	-0.0003	0.0012	-0.0141	-0.0197
	(0.0711)	(0.9961)	(0.0027)	(0.3406)	(0.0002)	(0.0084)	(0.2134)	(0.992)	(0.9616)	(0.6046)	(0.4883)
October	0.0634***	0.0918**	-0.3323***	0.1283	0.0704	-0.0813	0.1258***	0.0934***	-0.0146	0.0084	0.0509*
	(0.0000)	(0.0127)	(0.0001)	(0.6639)	(0.1522)	(0.1402)	(0.0005)	(0.0029)	(0.6795)	(0.7489)	(0.0537)
November	-0.0481***	0.0948**	-0.1895***	0.4505	0.0972**	0.0369	0.0063	0.0528	0.0307	0.0076	0.0085
	(0.0000)	(0.0154)	(0.0089)	(0.1982)	(0.043)	(0.4904)	(0.8416)	(0.1164)	(0.2988)	(0.8095)	(0.8053)
December	-0.0114	0.1699***	-0.0316	0.2069	0.0856*	-0.1011**	0.0773**	0.0768**	-0.027	0.0083	0.0488
	(0.3083)	(0.0002)	(0.6199)	(0.3349)	(0.0719)	(0.0323)	(0.0249)	(0.0124)	(0.2608)	(0.785)	(0.1227)

AR(1)	-0.2762*** (0.0005)	-0.6984*** (0.0000)	0.626*** (0.0000)	-0.7633*** (0.0000)	-0.8327*** (0.0000)	-0.1921** (0.0435)	0.6559*** (0.0000)	-0.5996*** (0.0000)	0.6691*** (0.0000)	0.8993*** (0.0000)	-0.4716*** (0.0002)
MA(1)	0.2864*** (0.0003)	0.716*** (0.0000)	-0.6625*** (0.0000)	0.771*** (0.0000)	0.8597*** (0.0000)	0.2194** (0.0221)	-0.6926*** (0.0000)	0.6254*** (0.0000)	-0.6565*** (0.0000)	-0.922*** (0.0000)	0.4949*** (0.0001)
Variance Eq.											
Constant	0.0577*** (0.0000)	0.0907*** (0.0000)	0.1176*** (0.0000)	0.3715 (0.1516)	0.0834*** (0.0000)	0.0569*** (0.0000)	0.0182 (0.1332)	0.0509*** (0.0000)	0.0271*** (0.0024)	0.1003*** (0.0000)	0.1305*** (0.0000)
ARCH	0.1189*** (0.0000)	0.1369*** (0.0000)	0.1706*** (0.0000)	0.0168*** (0.0000)	0.0974*** (0.0000)	0.1043*** (0.0000)	0.0625*** (0.0007)	0.0738*** (0.0000)	0.0781*** (0.0000)	0.1026*** (0.0000)	0.1433*** (0.0000)
GARCH	0.8604*** (0.0000)	0.8143*** (0.0000)	0.8284*** (0.0000)	0.9822*** (0.0000)	0.8713*** (0.0000)	0.8851*** (0.0000)	0.9326*** (0.0000)	0.8923*** (0.0000)	0.901*** (0.0000)	0.8396*** (0.0000)	0.7895*** (0.0000)

Appendix D-1 reports the results of January effect in the NAV returns of ALL ETFs.

D.2 January effect in the NAV returns of Asia Pacific ETFs

Appendix D- 2: January effect in the NAV returns of ALL ETFs

	Full sample period	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Mean Eq.											
January	0.0096 (0.5866)	0.1011* (0.0666)	-0.2644*** (0.0038)	0.5305** (0.026)	0.1972*** (0.0008)	-0.0785 (0.3696)	0.0708 (0.1795)	0.0086 (0.8134)	-0.0124 (0.8109)	-0.0258 (0.6071)	-0.0484 (0.3425)
February	0.0178 (0.343)	0.028 (0.5892)	-0.4334*** (0.0000)	-0.1823 (0.4243)	0.0146 (0.7866)	-0.0612 (0.541)	0.0396 (0.4961)	0.0193 (0.7194)	0.0144 (0.7916)	-0.0733 (0.2)	-0.0125 (0.762)
March	0.0381** (0.0314)	0.1751*** (0.0073)	-0.2855* (0.0881)	0.3858 (0.226)	0.119** (0.0244)	-0.0128 (0.8233)	0.0642 (0.1169)	-0.0085 (0.879)	0.0597** (0.0498)	-0.0661 (0.179)	-0.0013 (0.9761)
April	0.0281* (0.0905)	-0.0591 (0.5631)	-0.3104 (0.2217)	0.2097 (0.4512)	0.1236* (0.0506)	-0.0585 (0.3119)	0.0933* (0.0728)	0.1077** (0.0221)	-0.0011 (0.9769)	-0.105** (0.0464)	0.0328 (0.4084)
May	-0.0114 (0.5657)	0.1412 (0.1263)	-0.1836* (0.0984)	0.3467* (0.0635)	0.1625** (0.0147)	-0.0772 (0.2211)	0.0558 (0.1351)	0.0842** (0.0312)	-0.0209 (0.6026)	-0.0008 (0.9865)	0.0465 (0.2731)
June	-0.0134 (0.4999)	0.4385*** (0.0000)	-0.3836*** (0.0048)	0.311 (0.1578)	0.1263** (0.0363)	0.0413 (0.56)	0.0267 (0.4354)	0.0546 (0.2098)	0.0552 (0.1798)	0.0165 (0.7551)	0.0276 (0.5295)
July	0.0599*** (0.0025)	-0.072 (0.53)	-0.3841*** (0.0008)	0.4925** (0.0241)	0.0906 (0.2854)	0.0717 (0.1584)	0.1046** (0.0247)	-0.0665 (0.1653)	0.0257 (0.5432)	-0.0315 (0.4818)	-0.0205 (0.5563)
August	0.0159 (0.3904)	0.0037 (0.9694)	-0.1082 (0.3932)	0.3725 (0.2217)	0.0812 (0.115)	-0.1035 (0.109)	0.128*** (0.0076)	0.0687 (0.1609)	0.0421 (0.3086)	-0.0777** (0.0452)	-0.0006 (0.9886)

September	-0.003 (0.8697)	-0.1099 (0.2147)	0.0352 (0.7717)	-0.0833 (0.8311)	0.1447** (0.0349)	-0.1622*** (0.0058)	0.1609*** (0.0003)	-0.0354 (0.5868)	-0.0531 (0.114)	0.0098 (0.8185)	0.0186 (0.6498)
October	0.0348** (0.0251)	0.1534** (0.0101)	-0.0179 (0.8622)	0.7298* (0.0731)	0.1803*** (0.0034)	-0.0762 (0.2919)	0.0915** (0.0183)	0.0184 (0.6928)	-0.0052 (0.8864)	0.0094 (0.8265)	0.0364 (0.3837)
November	0.0108 (0.4978)	0.0501 (0.477)	-0.0913 (0.2048)	0.5342** (0.0483)	0.2659*** (0.0000)	0.0527 (0.65)	0.0265 (0.5522)	-0.0172 (0.6794)	0.0942* (0.0618)	-0.027 (0.5508)	0.0514 (0.3301)
December	0.0047 (0.7775)	0.262*** (0.0000)	-0.4724*** (0.0000)	0.0615 (0.7541)	-0.0307 (0.6127)	-0.1321** (0.0303)	0.0213 (0.701)	0.002 (0.9624)	0.0226 (0.6007)	0.0057 (0.9112)	-0.0602 (0.26)
AR(1)	0.0258 (0.7562)	-0.7092*** (0.0000)	-0.755*** (0.0000)	0.4839 (0.1232)	-0.8759*** (0.0000)	-0.04 (0.7802)	-0.38*** (0.0097)	-0.1449 (0.1101)	0.6285*** (0.0022)	-0.0929 (0.2857)	0.0814 (0.6311)
MA(1)	-0.0029 (0.972)	0.7609*** (0.0000)	0.699*** (0.0001)	-0.4529 (0.1595)	0.8922*** (0.0000)	0.0751 (0.5958)	0.3538** (0.0157)	0.1956** (0.0293)	-0.6211*** (0.0028)	0.1475* (0.0921)	-0.053 (0.7566)
Variance Eq.											
Constant	0.0522*** (0.0000)	0.1011*** (0.0001)	0.1786*** (0.0000)	0.1498 (0.1078)	0.0742*** (0.0000)	0.0653*** (0.0000)	0.019 (0.1009)	0.0482*** (0.0000)	0.0194* (0.058)	0.1491*** (0.0012)	0.0622*** (0.0053)
ARCH	0.1104*** (0.0000)	0.1375*** (0.0000)	0.166*** (0.0000)	0.0102** (0.0128)	0.0988*** (0.0000)	0.1017*** (0.0000)	0.0609*** (0.0002)	0.0988*** (0.0000)	0.0659*** (0.0003)	0.1271*** (0.0000)	0.0735*** (0.0000)
GARCH	0.8682*** (0.0000)	0.8239*** (0.0000)	0.8243*** (0.0000)	0.9888*** (0.0000)	0.8577*** (0.0000)	0.8794*** (0.0000)	0.9274*** (0.0000)	0.8747*** (0.0000)	0.9172*** (0.0000)	0.7866*** (0.0000)	0.8904*** (0.0000)

Appendix D-2 reports the results of January effect in the NAV returns of Asia Pacific ETFs.

D.3 January effect in the NAV returns of European ETFs

Appendix D- 3: January effect in the NAV returns of ALL ETFs

	Full sample period	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Mean Eq.											
January	0.0308* (0.0884)	0.0816** (0.0377)	-0.0837 (0.4112)	0.6518 (0.5119)	0.0854 (0.3194)	0.0705 (0.2883)	0.1616** (0.0155)	0.1259*** (0.0034)	-0.0175 (0.7526)	-0.0378 (0.4398)	0.0579 (0.1758)
February	0.0528*** (0.0049)	-0.0151 (0.8626)	-0.1482 (0.1473)	-0.1046 (0.8915)	0.0288 (0.6959)	-0.0696 (0.3837)	0.0649 (0.3571)	0.0683* (0.0698)	-0.0452 (0.3785)	0.0174 (0.7051)	0.0146 (0.7086)
March	0.0324* (0.0588)	0.0091 (0.849)	-0.0935 (0.2525)	0.1515 (0.8505)	-0.0089 (0.9083)	-0.1685** (0.0106)	0.1333** (0.0112)	0.1327*** (0.0000)	0.0355 (0.4121)	-0.0808** (0.039)	0.0249 (0.4601)
April	0.0297 (0.1085)	0.1771*** (0.0001)	-0.0794 (0.383)	0.2084 (0.6872)	0.1016 (0.2704)	-0.0013 (0.9869)	0.0335 (0.5802)	0.0778* (0.0613)	-0.0668* (0.0586)	-0.0404 (0.412)	-0.0095 (0.803)

May	0.0326* (0.0544)	0.1376*** (0.0088)	-0.0873 (0.4717)	0.1612 (0.8479)	0.1363* (0.085)	0.0317 (0.6854)	0.0393 (0.4446)	0.1012*** (0.0086)	-0.0403 (0.3155)	0.0138 (0.7697)	-0.0379 (0.2036)
June	-0.0101 (0.5616)	-0.003 (0.9462)	-0.1425 (0.1664)	0.0539 (0.9389)	-0.0306 (0.7347)	-0.1802** (0.034)	0.0564 (0.3424)	0.0811*** (0.0076)	0.0041 (0.93)	-0.0459 (0.2348)	-0.0333 (0.364)
July	-0.0108 (0.5573)	-0.1037** (0.0375)	-0.2307*** (0.0005)	0.5244 (0.4685)	0.1135 (0.135)	-0.1164* (0.0846)	0.1706*** (0.0022)	0.0757** (0.0495)	-0.0815** (0.0213)	0.0353 (0.2955)	-0.0064 (0.8859)
August	0.0278* (0.0994)	0.0722** (0.0239)	-0.508*** (0.0000)	1.8926 (0.3243)	0.1672*** (0.0099)	0.1136** (0.0455)	0.1424*** (0.0039)	0.0749* (0.0552)	0.0025 (0.9486)	0.0338 (0.3798)	-0.0472 (0.2604)
September	0.0379** (0.0279)	0.0126 (0.7927)	-0.1384 (0.2058)	-0.0094 (0.9893)	0.0307 (0.6951)	-0.1006 (0.1279)	0.0527 (0.204)	0.1075*** (0.0019)	-0.0182 (0.6301)	0.071* (0.0733)	0.0143 (0.7195)
October	0.0347** (0.0482)	0.1805*** (0.0003)	0.0006 (0.996)	0.0028 (0.9973)	0.1888*** (0.0049)	-0.0754 (0.3163)	0.0943 (0.136)	0.1139*** (0.004)	-0.0897* (0.0584)	0.0649 (0.1051)	0.1058*** (0.0074)
November	0.0062 (0.7466)	0.2058*** (0.0000)	0.0004 (0.9972)	0.9337 (0.1512)	0.2394*** (0.0005)	0.1062 (0.1148)	0.0582 (0.4126)	0.0771** (0.0278)	-0.0539 (0.2408)	0.0551 (0.1909)	0.0432 (0.18)
December	0.0134 (0.3775)	-0.0293 (0.283)	0.0703 (0.5393)	-0.9893 (0.3507)	0.112 (0.1362)	-0.2042*** (0.0059)	0.0455 (0.3955)	0.1005** (0.021)	-0.0703 (0.1419)	0.0296 (0.396)	-0.0816** (0.0162)
AR(1)	-0.4307*** (0.0000)	0.755*** (0.0000)	0.5759*** (0.0000)	-0.5867*** (0.0000)	-0.788*** (0.0000)	-0.3293** (0.0473)	0.6733*** (0.0000)	0.9306*** (0.0000)	-0.9287*** (0.0000)	-0.1594** (0.0125)	-0.6097*** (0.0000)
MA(1)	0.4373*** (0.0000)	-0.8299*** (0.0000)	-0.6014*** (0.0000)	0.5701*** (0.0000)	0.8292*** (0.0000)	0.3502** (0.036)	-0.7275*** (0.0000)	-0.9581*** (0.0000)	0.9198*** (0.0000)	0.1718*** (0.0061)	0.6388*** (0.0000)
Variance Eq.											
Constant	0.0623*** (0.0000)	0.1026*** (0.0000)	0.0807*** (0.0002)	0.5966 (0.9319)	0.158*** (0.0000)	0.0466*** (0.0000)	0.0321** (0.0184)	0.0372*** (0.0016)	0.0438*** (0.0087)	0.0801*** (0.0000)	0.1438*** (0.0000)
ARCH	0.1239*** (0.0000)	0.118*** (0.0000)	0.1593*** (0.0000)	0 (1)	0.095*** (0.0000)	0.0919*** (0.0000)	0.0482*** (0.0000)	0.0408*** (0.0000)	0.0958*** (0.0000)	0.0901*** (0.0000)	0.1917*** (0.0000)
GARCH	0.8562*** (0.0000)	0.8049*** (0.0000)	0.8397*** (0.0000)	0.999*** (0.0000)	0.8585*** (0.0000)	0.9014*** (0.0000)	0.9429*** (0.0000)	0.9309*** (0.0000)	0.8722*** (0.0000)	0.8644*** (0.0000)	0.7454*** (0.0000)

Appendix D-3 reports the results of January effect in the NAV returns of European ETFs.

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